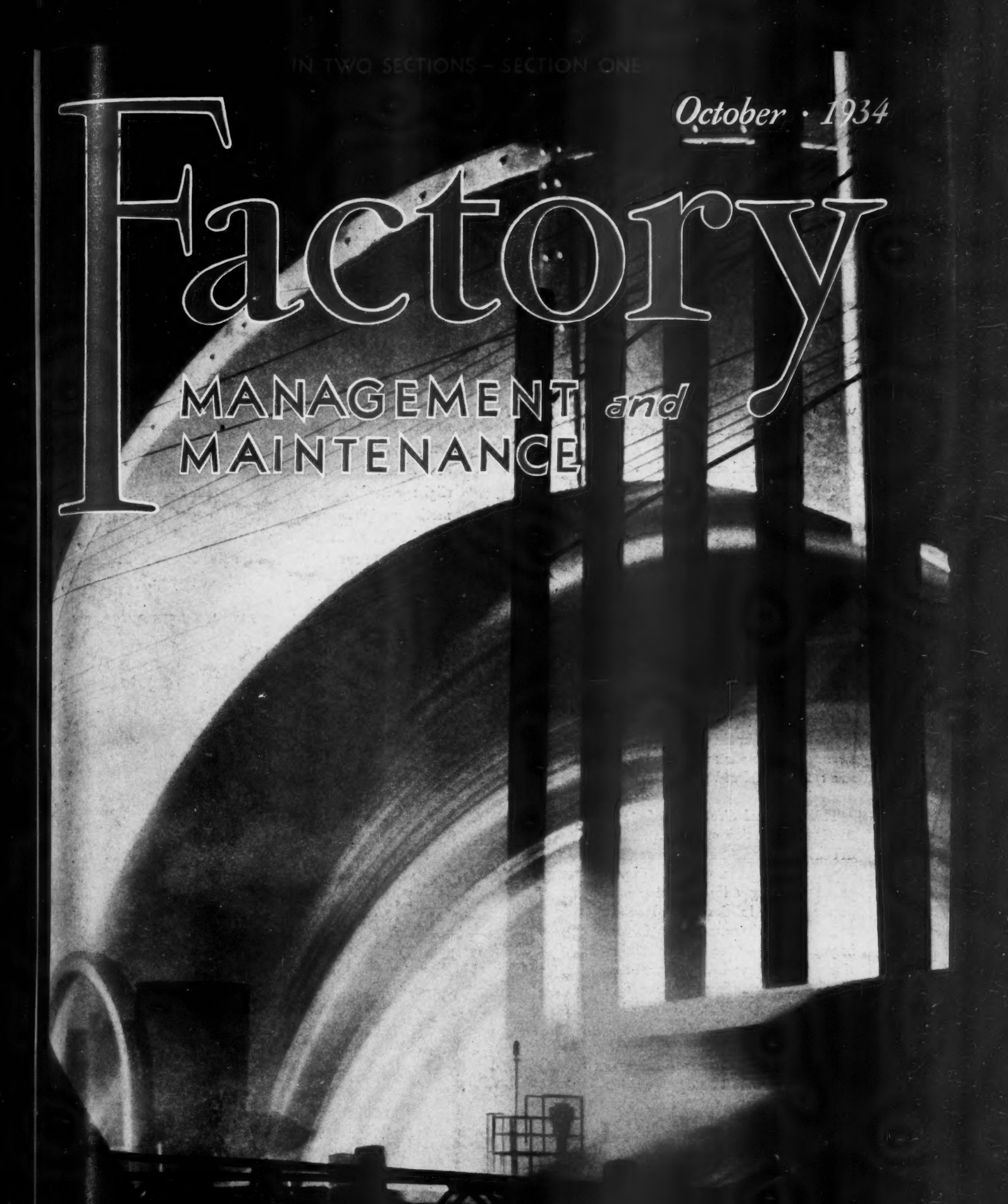
IN TWO SECTIONS—SECTION ONE

October · 1934

Factory

MANAGEMENT and MAINTENANCE



What Industry Can Do to 1935 Power Costs

Seven Special Articles

Power Loss Check Chart

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Factory Management *and* Maintenance

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OCTOBER • 1934

What Industry Can Do to 1935 Power Costs

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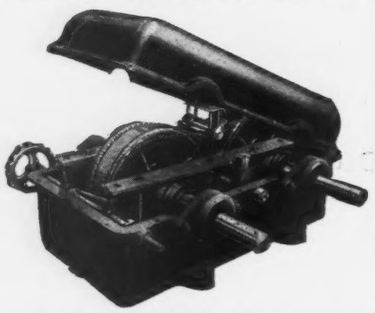

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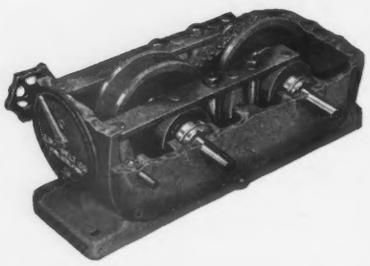

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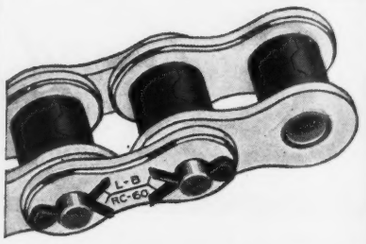

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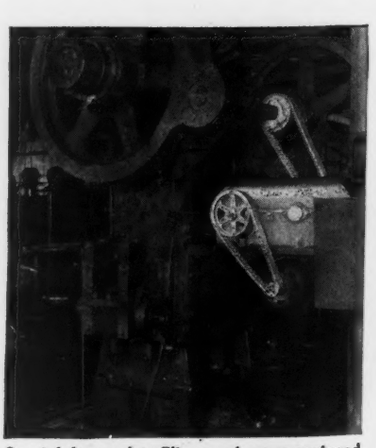

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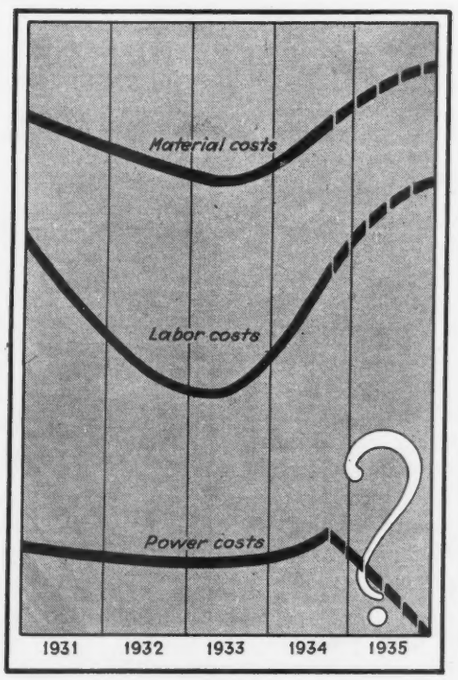
FACTORY MANAGEMENT and MAINTENANCE

OCTOBER, 1934

Add to Net Profits *by Stopping Power Wastes*



What will industry do in 1935 to the power cost curve? It can be pushed down. Special power articles in this issue and the Power Loss Check Chart—Section Two—tell how to do it

LAST year manufacturing industry paid out $750,000,000 in dividends. Next year industry's bill for fuel and purchased power will be at least as much as for last year. *Any year,* depending upon which power expert's figures you choose to accept, industry wastes from 20 to 50 per cent of the power it makes, plus a not inconsiderable amount of the energy it buys.

Industry, in other words, can in 1935 reduce waste in the generation, transmission, and use of power by an amount approaching 1933's dividends.

Let's analyze the opportunity conservatively. Industry's bill for purchased power in 1935 will be close to $500,000,000. It will spend $1,000,000,000 for the power it makes. Based on this figure for generated power alone, a reduction in waste of 35 per cent—which is arrived at by splitting the difference between the experts' high and low estimates—amounts to $350,000,000.

Industry can therefore add $350,000,000 to 1935's net profits, much more if the 50 per cent estimate is correct. A power dollar saved is a dollar added to net profits.

Whether donated to stockholders, invested in new plant and equipment, or—we like to think of this alternative—paid out in higher wages and salaries, this $350,000,000 is the one best answer to the plant operating man who pays little or no attention to power "because it is such a small part of total manufacturing expense."

There are still, curiously enough, a lot of him.

Power, says he, is only 3 per cent of our cost of doing business. Why worry?

Once that wasn't such a bad argument. Why worry, indeed, when opportunities to cut costs were so much more plentiful in other parts of the plant?

That was yesterday, however. Opportunities in other parts of the plant are not so plentiful today. Codes say how little you can pay employees, how many hours you can work them. Regardless of the resulting social good, costs of equipment, materials, and labor are correspondingly up. It's harder today to make savings where management has been accustomed to make them in the past.

And relatively easier to make savings by the simple process of eliminating power wastes.

Minimum wages, maximum hours, are fixed; minimum coal piles, maximum efficiencies, are not. Today, because wastes can be eliminated, power costs are a greater part of *controllable* manufacturing expense than at any time during the past four years.

Let the simple chart on this page tell the story. Never mind if the cost curves for materials and labor aren't strictly accurate. They serve merely to indicate the trend and to illustrate the point we want to make. *It's the third curve—power costs—which industry can most easily push down.* And don't forget that 4 to 10 per

cent always did come much closer to being the real ratio of power to total manufacturing costs than the 3 per cent so often cited.

Never has it been more essential to reduce manufacturing expense. Greater than ever is the need to produce commodities at costs that will insure wide distribution. Savings *must* be made. They *can* be made. And power wastes offer industry one of its biggest opportunities for saving in 1935.

What Will Management Do About It?

Management is responsible. The power engineer in the plant can do part of the job; the power consultant can do part; the electrical and mechanical engineers can do their share. But the over-all responsibility, from recognizing that the opportunity for saving exists to directing that something be done about it, is management's.

There are certain major considerations in determining power policy and procedure for a manufacturing plant.

First, shall power be made or bought?

If made, what equipment is to be used? What fuel? How control waste?

If purchased, how cooperate with the central station to keep the bills low?

In the actual application and utilization of power, how control waste?

Each major consideration breaks down into innumerable secondary considerations, each with its own array of problems. Many of them have to be solved by specialists.

The final responsibility, however, drops right into the lap of management.

That explains this issue of *Factory Management and Maintenance*. In it these problems are arrayed that they may be seen and recognized. Analyses by specialists on the pages that follow point the direction which management must take in these major considerations. And the "Power Loss Check Chart," Section 2 of this issue, which is *Factory's* unique contribution to the control of power wastes, presents in graphic form a breakdown by experts of the over-all power problem into hundreds of secondary considerations that have their influence upon the predetermination and control of power costs.

Who Wouldn't Rather Make 12 Per Cent Than 10?

Consider the conservative condition of a plant with generated power costs and net profits each representing 10 per cent of total manufacturing costs. Let's be modest and say that a reduction of, not 50 per cent, but only 20 per cent, in power costs is made.

At once, power costs become 8 per cent, net profits 12 per cent, of total costs.

When the spread between cost and selling price is low, a power saving of 20 per cent may easily represent the difference between a deficit and a profit. Almost any plant generating its power that has not had a good power engineering job done on it for the past several years can cut its power costs 20 per cent.

A plant with a 50 per cent waste, a power cost ratio of 10 per cent, and a total manufacturing cost of $1,000,000 can obviously save $50,000. That is interest at 5 per cent on a million. Even the plant well above the average has an attractive opportunity for saving. With waste only 20 per cent, power cost ratio 4 per cent, and manufacturing cost $1,000,000 the saving can still be $8,000—interest on $160,000.

Manufacturers of power equipment, for generation, transmission, and utilization, have increased the efficiency of their products. While manufacturing industry slumped, engineers continued their development work, now know more than ever about putting efficient equipment to work.

It is only the very new power layout that will not lend itself readily to worth-while economies. In most plants an engineering survey is immediately in order.

When the survey is made, it must be remembered that the cost of power includes not only the cost for generating equipment, for fuel and firing (or, if purchased, the cost of power delivered to the panelboard), but also the cost of transformation into electrical energy and the cost of transmission through transformers, electric power lines, motors, and mechanical equipment to the specific locations where useful work on the product is done.

What Has Been Done, Can Be Done

For proof of *what has been done,* look at the 100 (and more) cases cited on the back of the Power Loss Check Chart.

That's the picture. You go on from there.

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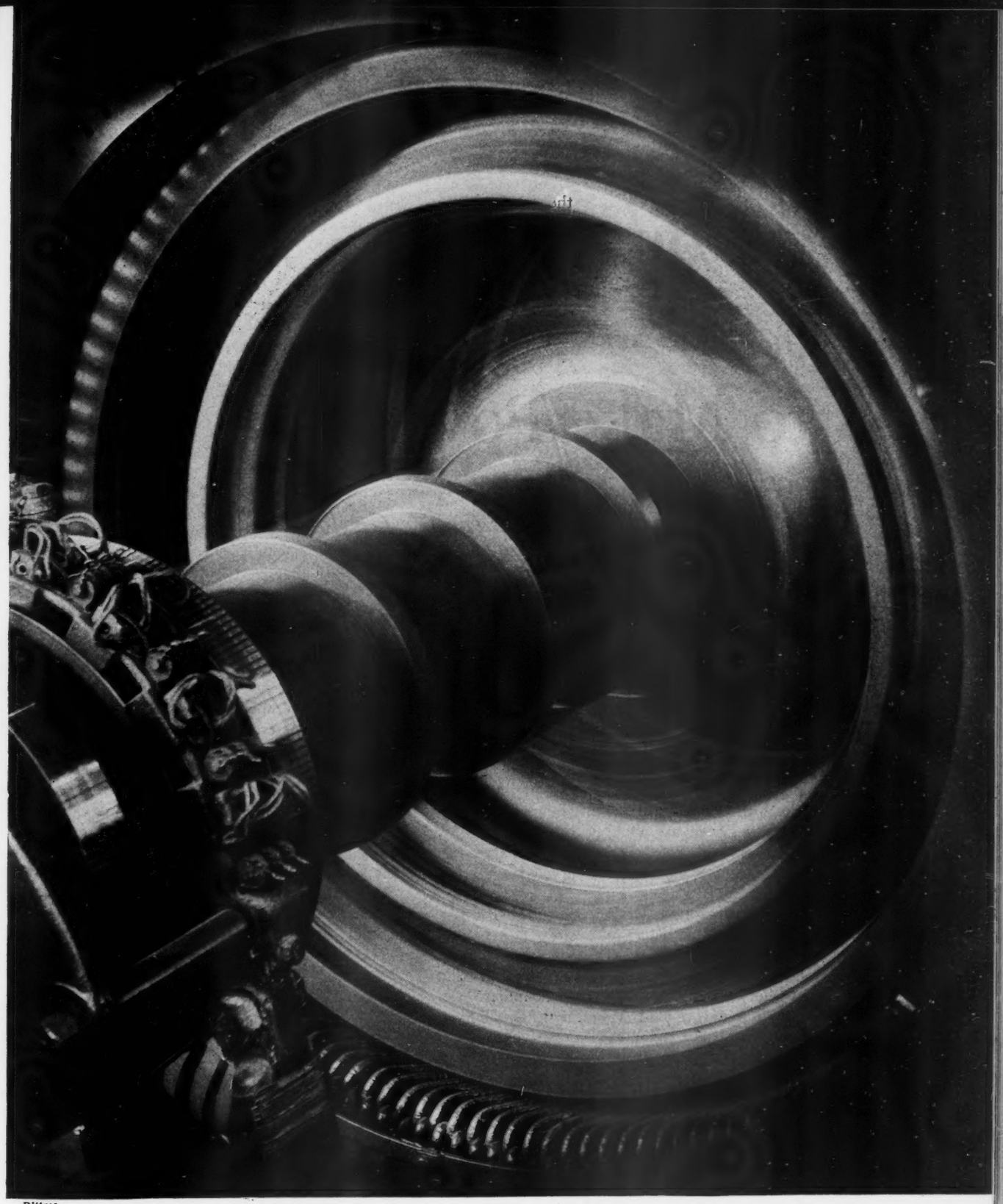
Section Two

Power Loss Check Chart

A key to industrial power plant economy

How 100 Plants Made Power Savings



Rittase

¶ Any year industry wastes between 20 and 50 per cent of the power it makes, plus a not inconsiderable amount of the power it buys

When to Buy Power *When* to Make Power

William W. Gaylord
Consulting Engineer
New Haven, Conn.

EVERY industrial plant, at some time or other, faces the question "To Buy or Make Power?" The correct answer is always the same: "The decision must depend upon the specific conditions governing the use of power." Unless the management of the plant is willing to accept that answer, is willing to go through the exacting engineering work to provide the data for a decision, and is willing to foot the bills for an investigation, it may as well toss a coin and abide by the result. Let me indicate the variables that must be considered.

Purchased power costs are made up of:

1. A demand charge representing fixed charges on that part of the utility's equipment reserved for the use of the customer.
2. An energy charge representing operating costs.
3. Service charges, for meters, etc.
4. Investment charges on the cost of transformers, transformer vaults, and lines from transformers to main switchboard where supplied and owned by customer.

The first three items are covered by the utility's billing, but the fourth is not and is sometimes overlooked.

Generated power costs are made up of:

1. Operating costs, including fuel, labor, supplies.
2. Maintenance costs on all power equipment up to the main switchboard.
3. Investment charges on costs of power plant equipment up to the main switchboard.
4. Insurance and taxes on power plant and equipment.

First Costs, Generated Power

Average relative first costs of generating plants will be about these:

Steam engine driven, from $250 per kw. for a 100-kw. plant to $180 per kw. for a 1,000-kw. plant.

Steam turbine driven, same capacities, $200 to $140.

Diesel engine driven, same capacities, $160 to $100.

(Figures do not show credit for cost of boiler plant for heating and process steam if power were not made.)

Average relative operating costs per kw.-hr. (for fuel, lubricating oil, supplies, labor, maintenance) are shown immediately below. The figures in bold face are the *total* costs, on the same capacity bases. They are secured by adding to the operating costs the fixed or investment charges (for interest, depreciation, taxes, insurance), based on an output of 1,500 kw.-hr. per year per kw.

Steam engine, non-condensing, from 2.3c. for a 100-kw. plant to 1.9c. for a 400-kw. plant. **(4.5c. to 3.65c.)**

Steam turbine, non-condensing, same capacities, 3.4c. to 2.68c. **(5.16c. to 4.22c.)**

Steam engine, condensing, from 1.3c. for a 250-kw. plant to 1.1c. for a 1,000-kw. plant. **(3.18c. to 2.69c.)**

Steam turbine, condensing, same capacities, 1.45c. to 1.07c. **(2.93c. to 2.3c.)**

Diesel, from 1.31c. for a 100-kw. plant to 0.91c. for a 1,000-kw. plant. **(2.72c. to 1.79c.)**

Average Costs, Purchased Power

The average cost of purchased power per kilowatt-hour under the same conditions will be 3.17c. for a 100-kw. plant, 2.80c. for a 250-kw. plant, 2.55c. for a 400-kw. plant and 2.15c. for a 1,000-kw. plant.

If 35 per cent of the total steam supplied to the generating plant is required for heating, for six months of the year, first cost chargeable to power generation will vary from $200 to $125 per kw., operating cost from 2.2c. to 1c. per kw.-hr., total cost from 3.9c. to 2.1c. per kw.-hr. for plants from 100- to 1,000-kw. capacity.

If requirements for process, as well as heating, advance this percentage to 75, first cost will be $130 to $100, operating cost 1.02c. to 0.61c., total cost 2.14c. to 1.49c.

Assume a connected load of 1,050 kw., a demand load of 920 kw., and use of an average of 125,000 kw.-hr. per month. Purchased current is available, but to get the best rate the factory must put in its own substation consisting of transformers in a vault with lines

to switchboard. This will cost $9,000 installed. The cost of purchased power per month will then be:

Demand, 920 kw.	$ 1,227.50
Energy, 125,000 kw.-hr.	1,435.25
Service charges	0.00
Investment charges, $9,000 @ 1.1 per cent	99.00
Total	$ 2,761.75
Total annual cost	33,141.00
Cost per kw.-hr. 2.21c.	

Steam for building heating will be required for six months in the year so a boiler plant will be necessary even if power is purchased. Assume that an average of 6,000 pounds and maximum of 15,000 pounds of steam per hour will be required. Two methods can be used to supply this and reduce the cost of steam-generated power: first, from bleeder-type condensing turbines used to supply all power required; second, from a back-pressure turbine which will be operated six months at the load required to supply the steam for heating. The balance of the power is purchased.

Two Ways of Working Out a Case

The first method will require two 300-hp. boilers and two 500-kw. bleeder-type condensing turbines with auxiliaries. The cost of this plant will be $125,000 more than that for heating only. The annual power costs will be:

Fuel, 1,516 tons @ $6	$ 9,096
Labor, 2,250 hours @ 60c. + 1,200 hours at 50c.	1,950
Supplies	300
Maintenance	2,500
Investment, taxes & insurance $125,000 @ 13.2 per cent.	16,500
Total annual cost	$30,346
Cost per kw.-hr. 2.02c.	

The second method will require two 200-hp. boilers and one 400-kw. back-pressure turbine with the same substation as required for purchased power. The cost of this generating plant will be $25,000 more than the boiler plant for heating only, and the cost of substation will make the total investment $34,000. The total annual power cost figured as above will be $32,551, and the cost per kw.-hr. 2.17c.

A diesel generating plant, consisting of two 500-kw. units or three 340-kw. units will cost $100,000 and the total annual power cost will be $26,900 making the cost per kilowatt-hour 1.79c.

If 10,000 pounds of steam per hour is required for process, in addition to that used for heating, the cost of steam generated power will be much lower. If bleeder-type turbines are installed and all power is generated, the additional first cost will be $100,000, the total annual power cost $22,250, and the cost per kilowatt-hour 1.48c.

If a back-pressure turbine is installed and operated at the load required to furnish the necessary low pressure steam with the balance of the power purchased, the first cost for generating equipment and substation will be $50,000, the total annual power cost $24,700, and the cost per kw.-hr. 1.65c.

The power costs for the 1,000-kw. plant, together with investments required and saving possible, may then be summarized on a basis of 2,000 operating hours a year.

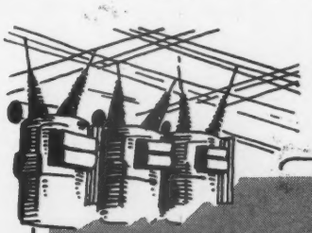
Power Supply	Investment Required	Annual Cost Inc. Fixed Charges	Saving over Purchased Power	Return on Investment, %*
Purchased	9,000	33,141		
Steam Generated Heating Steam Bled.	125,000	30,346	2,795	13.0
Purchased and Generated from Steam for Heating	34,000	32,551	590	12.5
Diesel Generated	100,000	26,900	6,241	17.0
Steam Generated Heating & Process Steam Bled	100,000	22,250	10,891	21.7
Purchased and Generated from Steam for Heating and Process	50,000	24,900	8,441	27.7

*Includes 10.8 per cent allowed for interest and depreciation in figures for total annual cost.

The examples considered show that purchased power has a large advantage in low first cost, and will in most cases show a lower cost per kw.-hr. than steam generated power unless there is a considerable demand for low-pressure steam coincident with the power demand.

Where large quantities of low-pressure steam are required steam generated power will show a large saving. Diesel-generated power will in many cases offer sufficient savings over purchased power to be worthy of careful consideration when large quantities of low-pressure steam are not required.

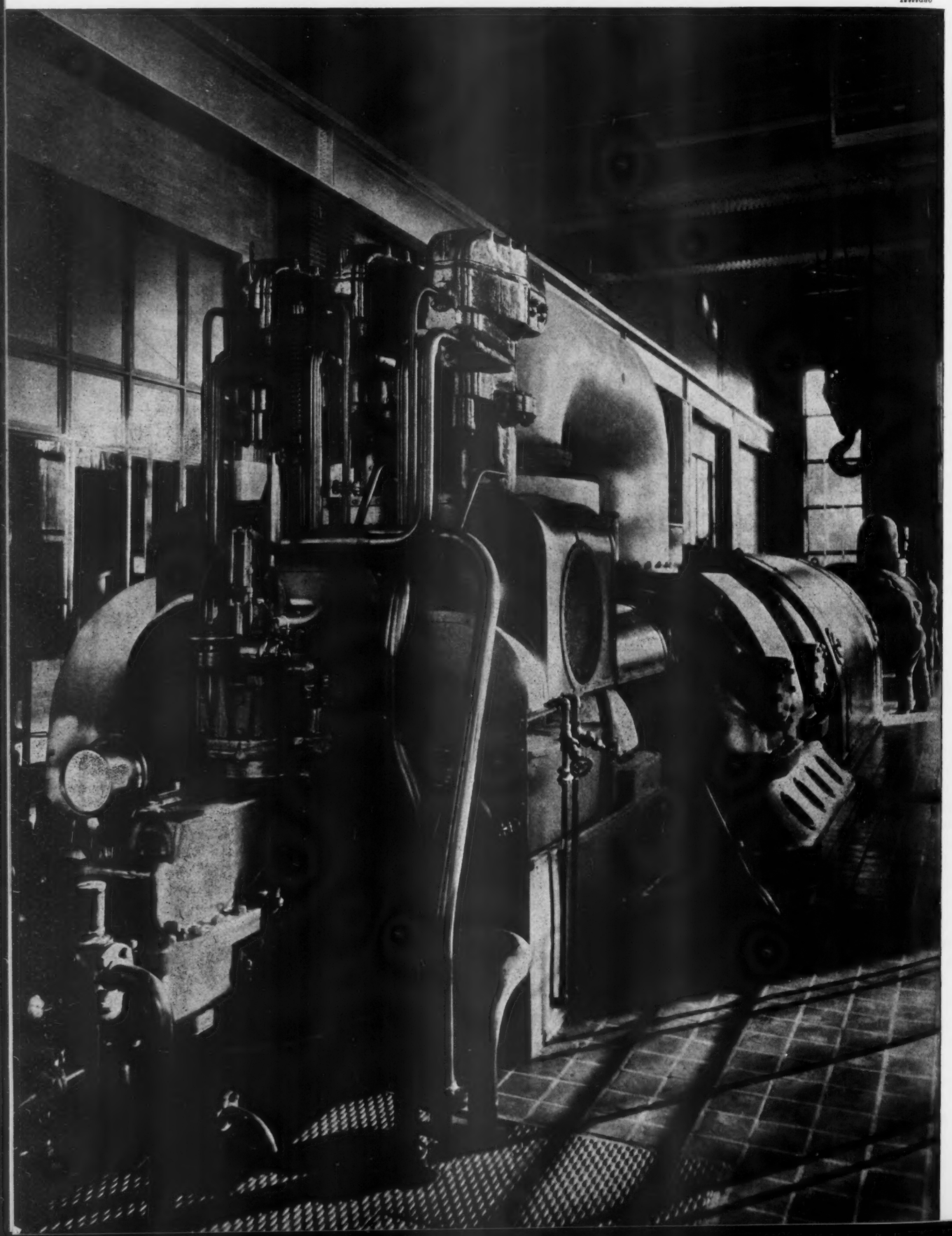
The reliability of a power supply is often as important as its cost. Purchased power has in most cases been found very reliable, although in some places minor service interruptions must be expected due to transmission line troubles caused by storms. Properly designed modern generating plants, both steam and diesel, have been found so reliable that spare generating units are not justified unless the plant operates at nearly full load for 24 hours a day, or special conditions make an absolutely continuous power supply essential. In the latter case standby generating equipment would be necessary even when using purchased power.



Power costs are too often looked upon by plant operating men as a secondary field for saving because they represent only 4 to 10 per cent of total manufacturing costs. Halved, they may turn a destructive deficit into a pleasant profit

¶ To buy or to make power? Decision depends, not upon the toss of a coin, but upon specific conditions governing the use of power

Rittase



How to Reduce Cost of Generated Power

Philip W. Swain

Editor, POWER

WHETHER an industrial plant generates steam and electricity, or steam only, the boiler room is the big problem. There lie the greatest potential savings in most plants—the opportunity to reduce fuel bills from 10 to 25 per cent.

Look at the Boiler Room

The typical modern power plant is rather simple in its essential elements. Feed water is purified, heated, and pumped to the boiler where coal, oil, or gas is burned to produce steam. This steam, usually superheated, drives an engine or turbine, which in turn drives a generator. Exhaust steam from the prime mover goes to a condenser, or to factory heating, or process, or is wasted to the atmosphere. Additional process and heating steam may be "bled" from the turbine; some may be taken directly from the boilers. Waterwheels, diesel, or gas engines may generate additional power.

Running into the boiler room is a steady stream of "returns"—warm, distilled water that is condensed steam. Returns may range from 98 per cent of the steam produced down to practically nothing, in extreme cases. Fresh "make-up" water must be added to make the total boiler feed equal to the steam produced. The mixture of "returns" and treated water is then heated, usually to 212 degrees F., at least, by exhaust steam.

Hot gases from the boiler may give part of their heat to air preheaters, or economizers, or both.

This typical, good boiler room is equipped with many instruments that indicate and record temperatures, pressures, and flow of water, steam, air, gas.

Which Fuel?

Fuel choice, in general, involves coal, oil, natural gas, and local waste fuels. The latter are problems of specific industries and need not be considered here.

Coal may be bituminous, semi-bituminous, sub-bituminous, lignite, or anthracite. Bituminous coals differ in heat value, water, sulphur, and ash content. Some clinker badly; some do not. Some smoke heavily; some lightly. Those that smoke and clinker badly under some conditions are satisfactory with more adaptable firing equipment and more skillful operation. Finally, coals vary widely in size and price.

Hopelessly confused, nevertheless, coal selection is a vital problem of management. What to do? Turn it over to a specialist. Smart coal selection may save 50 cents or more per ton. If B.t.u. bargains have to be missed because the equipment has to be babied—install firing equipment that can handle a variety of coals, particularly "bad" coals.

Figuring the heat cost of any fuel is a simple operation. Example: Coal of 13,000 B.t.u. a pound costs $4 a ton, delivered. A ton gives $13,000 \times 2,000 = 26,000,000$ B.t.u. Heat cost is $\$4 \div 26 = 15.4$ cents a million B.t.u.

Obviously, the fuel with the lowest heat cost is best *if* other things are equal; usually they are not. For example, labor cost is less with gas than with coal.

Coal Versus Oil and Gas

With oil there are fewer choices, but still opportunity to save by equipment that will handle the cheapest oils.

Natural gas usually gives but one choice, if any, in a given locality; hence, there is no problem of selection.

If oil or gas costs little more per million heat units it is commonly preferable to coal because of labor saving but—figure it out! Where there is close competition among these fuels, it may pay to install equipment that will handle all three, or two of them.

Most plants burn coal and will in the future. Forget hand firing; it is obsolete and wasteful. Stokers and pulverized fuel burners are close competitors, efficient, labor saving. An expert must decide which is best for a given plant and then choose among underfeed, overfeed, and travelling grate stokers, and between the storage and unit pulverized coal systems.

Coal and ash handling should almost invariably be mechanical. It is easy to figure the investment value of coal-handling equipment, based on its cost of equipment and the labor it will save.

Always provide for coal weighing; otherwise it is impossible to check boiler efficiency.

Choice of boilers usually narrows down to the water-tube type with horizontal or inclined tubes. It will often

pay to use a furnace with water-cooled walls. It is higher in first cost, but gives greatly increased capacity and reduced maintenance.

Plugging Heat Wastes

Economizers and/or air preheaters salvage waste heat from the stack. They may, or may not, pay handsomely on the investment, depending on local conditions.

In water treatment there is a wide range of choice, but no safe avoidance of the problem. One must treat the feed water or accept burned tubes, shutdowns, heavy maintenance, and the low efficiency of scaled tubes. Only an expert can choose intelligently the proper system.

Scale from hard water blocks off heat flow. One-eighth inch of scale may run the coal bill up to 5 or 10 per cent. It may also cause boiler tubes to overheat and burn out.

Two things may be stated definitely: First, water pure enough to drink may be very "impure" as boiler feed. Second, keep away from the many patent medicine "boiler compounds."

Heat the boiler feed water as hot as possible. Each 10 degrees of heating saves 1 per cent of the fuel bill.

An adequate set of boiler-room instruments will probably save more than 10 per cent of the coal bill. They should indicate and record steam pressure, steam temperature, feed water pressure and temperature, weight of feed water, quantity of steam produced.

Air Is the Biggest Waster

There should be a CO_2 recorder, or other instrument enabling the operator to maintain the correct proportions of air and fuel. Theoretically, it requires from 11 to 15 pounds of air to burn 1 pound of coal. Practically, it can be done with about 20 per cent more. Every extra pound of air fed goes up the stack full of waste heat.

Ten pounds of unnecessary air per pound of fuel will waste about 10 per cent of the fuel purchased.

Raising the CO_2 from 6 per cent to 14 per cent will cut the heat loss from 34 per cent to 15. In general the CO_2 content of stack gas should be 12 and 15 per cent.

Soot on tubes is another source of loss. Install and use soot blowers.

Boiler settings should be kept tight to avoid air leaks, which cause excess air and low CO_2. Baffles, also, should be tight.

What is good boiler efficiency for an industrial boiler plant of moderate size? I should rate efficiencies about this way: 85 per cent, extremely good; 80 per cent, very good; 75 per cent, good; 70 per cent, fair; 65 per cent, poor; 60 per cent, bad.

Boiler Room Management

To check the quality of boiler room operation get monthly reports covering, at least: Total steam produced, thousands of pounds; total coal burned, pounds; evaporation per pound of coal; boiler room efficiency, per cent (net); total cost of fuel; total cost of labor; total cost of repairs, maintenance, and supplies; total operating cost; fuel cost per 1,000 pounds of steam; operating cost per 1,000 pounds of steam.

For a given plant a specialist should be able to establish suitable standards covering these quantities.

In the engine room and the remainder of the plant the problem involves equipment selection and hookup more than operation. Engine-room savings are *built into* the plant.

If it has not already been done, a complete heat-flow diagram should be made of the power plant to see just where all the energy goes. In a balanced plant no steam passes to atmosphere or condenser; all exhaust is absorbed by the heating and process system.

Here the type of industry makes a difference. It is easy for a dyehouse to absorb all the exhaust but more difficult for a machine shop which needs relatively more power and less heat.

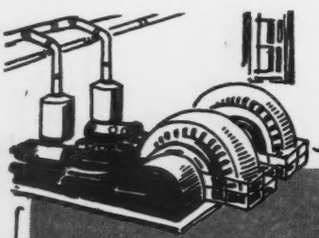
Where exhaust steam is being wasted, make the engines or turbines use less steam by installing more efficient units, or using higher steam pressure.

A heat balance will show whether turbines or engines are better, and whether to replace old units. Changing may save thousands of dollars, or not a cent. It all depends on the heat balance.

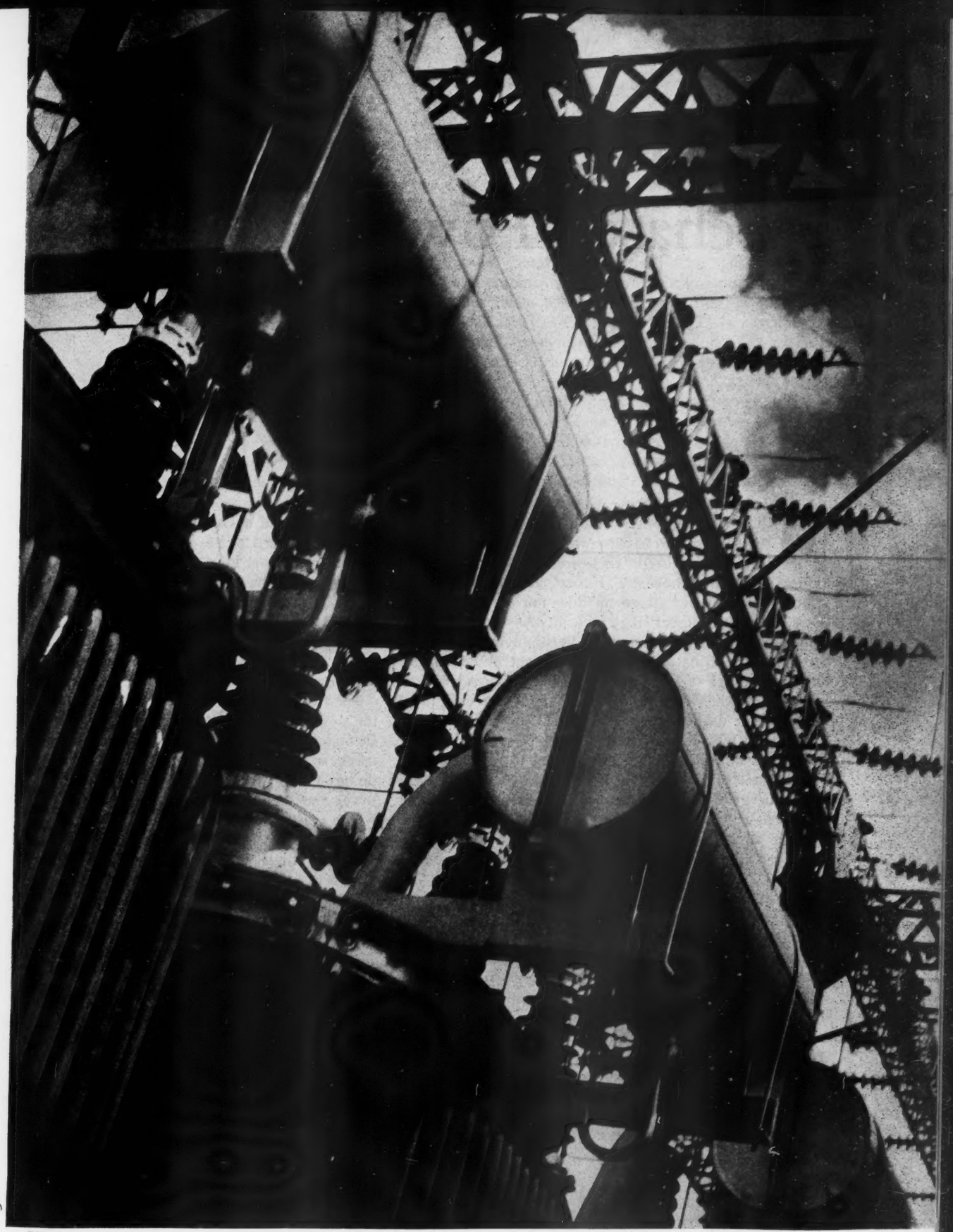
Diesel Engines

Where large amounts of steam are required for process and heating, steam prime movers will usually be most economical. Low process and heating load favor the diesel engine. It is the most efficient of all prime movers, except a steam engine or turbine generating byproduct power. Sometimes a combination of diesel and steam engines pays, the diesel carrying load that cannot be generated as a byproduct.

It all comes back to the heat balance. Without that analysis it is quite impossible for management to select prime movers intelligently.



Power costs have grown in relative importance as other costs have become harder to control. Whatever industry's 1935 power and fuel bill may be, savings may be had for the taking if management will recognize the opportunities ahead



Rittase

¶ Dollars paid for purchased power may be dissipated by needlessly high demand, low power factor, on-peak loading, wasteful application

How to Reduce Purchased Power Bills

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MUCH can be done by industrial plants to reduce the cost of purchased power! Furthermore, any legitimate effort in this direction will, according to my experience, have the hearty cooperation of the utility. If the latter statement does not seem to "make sense," just remember that a utility is an enterprise whose existence is dependent upon supplying more and better service to its customers at constant or decreasing unit prices. If it fails in this respect industry makes its own power, commercial and domestic customers restrict their usage.

How can bills for purchased power be reduced? The answer to this question will be easier to understand if one has a clear conception of the basis on which electrical energy is sold. For various reasons that cannot be discussed here, it is not possible for a utility to average all of its costs and charge each customer a flat price per unit, as does the merchant who sells, say, coal.

New Names for Old

It is, therefore, necessary to resolve the cost of supplying service into its various elements which are separately specified in the contract. These fundamentals are familiar things under new names, and may be found in the rates of most utilities under the headings "demand charge" and "current charge." They are really our old friends fixed charges and operating costs paid for separately instead of being lumped into one price. The demand charge represents the fixed costs of doing business, investment charges, etc., on the generating and associated equipment necessary to maintain available capacity at the customer's plant for 24 hours a day. Under these circumstances, with a given amount of capacity required by the customer, the relation of the fixed or demand charge to the total bill will be greater or less depending upon the use which he makes of the capacity reserved for him. This is equally true of the machinery in a factory.

Current charges are made up primarily of the operating costs of a utility and the relation between the current charges or operating costs and the demand charges or fixed costs, expresses the relationship between fixed and operating costs in the supply of service.

It is not hard to see that it costs more to serve the customer who requires 100 kilowatts of capacity and uses it for 5 hours a day, with a resultant consumption of 500 kilowatt-hours, than the customer who requires only 50 kilowatts capacity but uses it for 10 hours a day, with a resultant consumption of 500 kilowatt-hours. The consumption of the two customers is the same but their load factors are different.

Another element that strongly influences the size of the power bill is power factor. For the present, power factor can be regarded as the ratio between the current taken from the power lines to the current consumed in doing useful work. The greater the discrepancy, the lower the power factor. Low values of power factor, which is usually expressed as a percentage, are distinctly bad and increase costs for both customer and utility.

Use of high- or low-tension service, whether demand is assessed or measured, off-peak or seasonal rates, and so on, likewise affect the charges for purchased power.

With this background, brief as it is, it will be apparent that efforts to reduce the cost of purchased power should be directed along these lines, which, of course, overlap at some points: (1) Discussion of the problem with the utility to determine whether the lowest rate is being earned, or, if not, how it can be earned; (2) reduction in demand; (3) improvement of power factor and operating conditions, looking toward elimination of waste.

Why It Pays to Talk Things Over

There are several reasons why it will pay to discuss the problem of power cost reduction with the utility. A plant may drift away from the original load cycle without realizing it. Additions of a few motors or other changes in the load may make it eligible for another rate. Changes in production methods may increase or decrease demand in relation to consumption. Oftentimes, too, the utility's engineers can make valuable suggestions on ways of improving conditions.

Rescheduling of the entire load to take advantage of off-peak rates is a common method of reducing power costs. We have a number of customers who are doing

this. In one case a customer reduced his earned rate from 1½ cents a kilowatt-hour to 9 mills by shifting operations from day to night. Since power cost was a high percentage of his total production expense, the resultant economy in unit production cost was very gratifying.

Reduction in demand frequently offers important opportunities for reducing power bills. If the demand is measured it is common practice, although not universal, to base the demand on the maximum consumption in any 30-minute period during the month. In many instances careful handling and supervision of equipment operations will prevent unnecessary piling up of load at any one time. Thus, the starting of large motors may be staggered. Again, operations may be scheduled so that when one or more units of certain kinds of equipment that impose a heavy load, such as electric furnaces or large motors, are operated, other units will be shut down. Sometimes mechanical load on equipment can be adjusted to reduce demand without disadvantage. In one instance, study of the operation of beaters in a paper mill resulted in a setting which reduced the electrical demand without changing product quality.

Demand-limiting devices are available which automatically disconnect a portion of the load at a predetermined demand. With these devices the best results are obtained when a large part of the load can be disconnected for a short period at any time, without interfering with production. Electric furnaces, air compressors, and the like can sometimes be handled in this way.

What Low Power Factor Means to the Utility

Mention was made previously of the fact that low power factor is undesirable from every standpoint. To the utility it means uselessly tying up generator, transmission line, and other equipment capacity from which there is no return. For this reason many utilities penalize power factors below a certain value, usually 80 per cent, and may or may not allow a bonus for values of power factor above, say, 90 per cent.

There are two ways of handling the problem of low power factor: (1) Remove the cause as completely as possible; (2) correct the condition.

Low power factor is largely caused by another undesirable condition—improper selection of motor sizes. The majority of alternating-current motors used in industry are the so-called squirrel-cage induction type. When operated at somewhere near rated load modern squirrel-cage motors have a power factor of 85 to 90 per cent. However, the power factor falls off rapidly as the load decreases so that if a plant has many underloaded motors the power factor is certain to be objectionably low. Plainly, the remedy is to shift motors around until all are loaded as close as possible to rating.

Use of motors that are too large for the load is disadvantageous in other ways. For example, it increases capital investment unnecessarily and may easily be the cause of unduly high demand. Assuming that motors are properly loaded, there may be unnecessary waste of power in the mechanical drives.

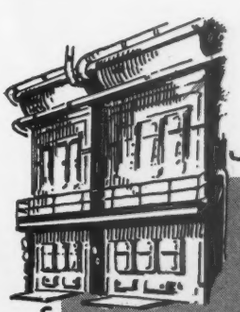
It is not always realized that transformers are the source of definite losses, even when they are not delivering current from the secondary, or low-voltage side. When purchased power is metered on the primary or high-voltage side a worth-while saving can often be made by disconnecting large transformers from the line over week-ends and holidays. In one instance a saving of nearly $300 a year was made in this way.

Frequently relocation of motors will not suffice to raise power factor to the desired value, possibly because of the operation of a large number of small motors or other equipment which has inherently a low power factor. In such cases the remedy lies (1) in carrying part of the load by synchronous motors, or (2) installing static condensers, usually referred to as capacitors.

An example of the advantages to be gained through power factor correction is found in a hosiery mill operating a number of 1- and 1½-hp. motors and a few somewhat larger. The feeders had evidently been designed for a power factor of about 80 per cent and were, therefore, entirely inadequate when the load eventually developed a power factor of less than 34 per cent.

After installation of small capacitors at the motors raised the power factor to 80 per cent, heating of feeders and connections disappeared and motor operation became normal. Billed demand was reduced 45 per cent; the total power bill was cut 32.2 per cent, representing a saving of more than $1,400 a year, and a reduction of 34 per cent in the cost of power per dozen pairs of hose.

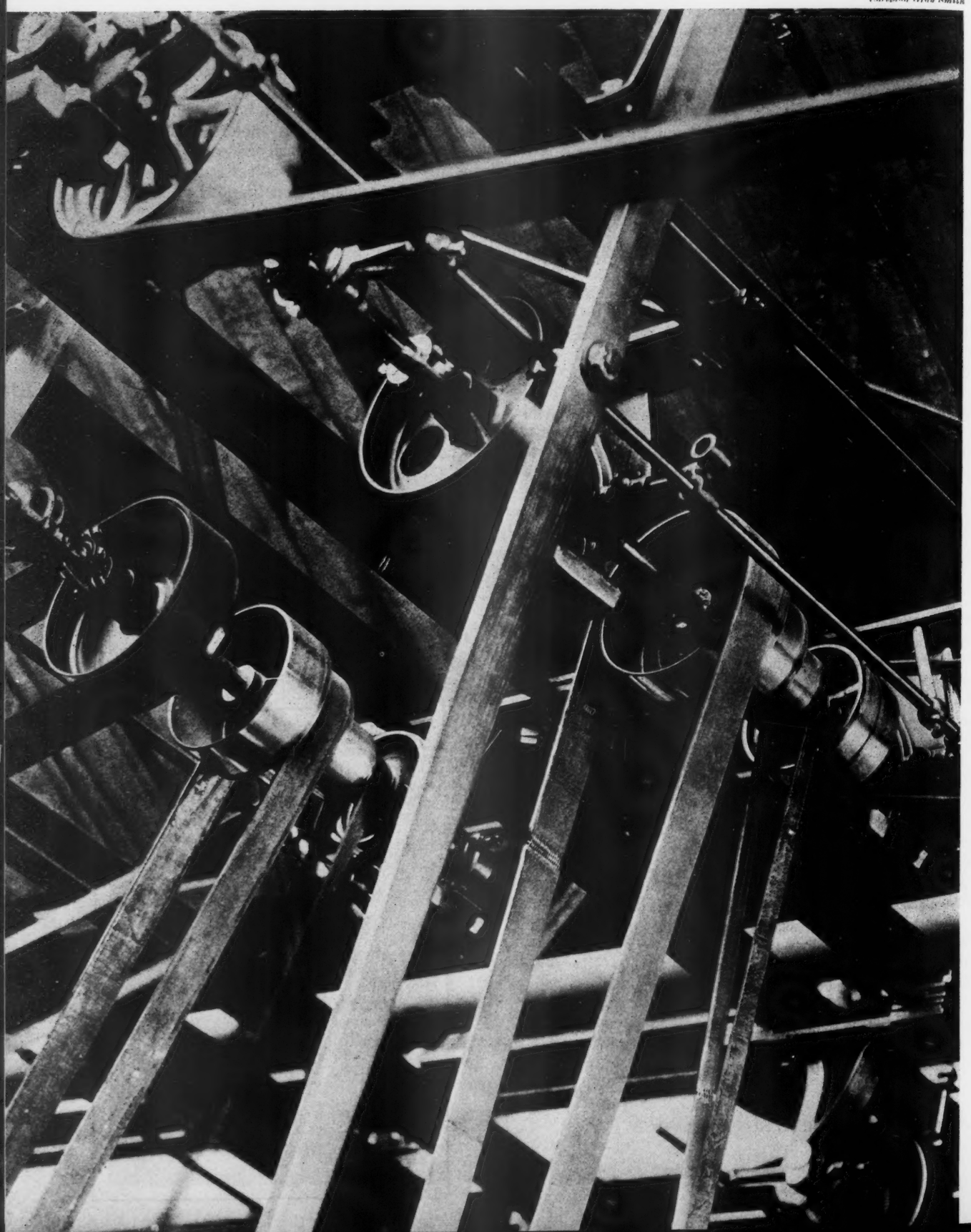
There is still another source of waste that can be eliminated only by constant watchfulness on the part of management. I refer to the operation of motors, lights, and other equipment when not in use. No argument is needed to show that considerable amounts of power can be needlessly consumed in this way and, of course, power bills are correspondingly increased. Management can prevent this waste by proper instruction and supervision of every one concerned in the operation of plant equipment.



Power costs are a potential source of direct net profits. A dollar lost in sales may mean but five cents lost in net profits. But a dollar lost in power costs is 100 cents lost in net profits. Power wastes saved are net profits gained

¶ It is only the exceptional plant that does not offer a surprising number of opportunities for important improvements in mechanical transmission

Cortland Gray Smith



Where to Find Wastes in Mechanical Transmission

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THERE'S many a slip in the process of transmitting power from the shaft of the motor to the shaft of the driven machine, many a hole or crevice into which a certain amount of power disappears to be seen no more. Transfer of power from a prime mover to the driven equipment may be likened to the crossing of a number of toll bridges with such names as Bearings, Belts, Gears, Chains, and so on. Some toll must be paid to each, but it is good business to pay no more than necessary.

First Choose Your Drive

The problem of attaining these ends begins with the selection of the method of driving the machine and the equipment used. Machines may be driven individually, in which case each has its own motor. The motor may be connected directly to the driven shaft by means of a coupling, or power may be transmitted through a separate or in-built speed reducer, open gearing, a belt of one type or another, a chain, or a variable-speed transmission.

In the other system of driving, a number of machines are operated from a common lineshaft driven by one motor. The drive connection between the motor and lineshaft is usually a belt, although chains are sometimes used. A belt is usually employed to transmit power from the lineshaft to the machine. Frequently a countershaft or jackshaft is interposed between lineshaft and machine.

Any study of ways to reduce power costs should involve a survey of the methods used in driving production machines, in view of the possibility that worthwhile savings can be made by changing drives. The individual and group systems both have inherent advantages and disadvantages that influence their application. Frequently production needs or local conditions clearly indicate choice of one or the other of these two systems. In the absence of such considerations a choice should be based on the relative advantages of each type, initial, operating, and maintenance costs, effect on the power supply, and so on.

The next step is to consider how losses can be cut in individual items of equipment. Since bearings are common to all mechanical power transmission devices, they are considered first.

Bearings are of two general types: (1) Plain or sleeve, in which the journal turns in a sleeve made of some alloy or non-metallic material; (2) anti-friction, in which the load is carried on hardened steel balls or rollers. Good sleeve bearings are dependable and efficient for medium and low speeds, if properly lubricated.

Ball and roller bearings reduce friction and require a minimum of lubrication and attention. Hence, it is economy to use them for normal and high-speed applications whenever their higher initial cost can be justified. With the exception of the split roller type, ball and roller bearings are of solid construction; therefore, when applied to lineshafts, the cost of replacement must be considered.

Excessive bearing losses and high bearing maintenance costs may be caused by one or more of several conditions, such as wrong type for load and speed, shafting misalignment and excessive deflection, improper lubricant, improper application of lubricant, wrong kind of bearing metal, wrong type of anti-friction bearing, improper or inadequate support.

After Breakage, Shutdown

Shafting is subjected to torsional and bending stresses; therefore, if it is overloaded, abnormal deflection and/or breakage occurs. Deflection causes high bearing friction and maintenance. Breakage results in shutdown.

With low-speed shafting, first cost can be lowered by using an alloy steel in place of the usual cold-drawn stock, since a much smaller diameter can be employed for a given load. To avoid deflecting a shaft above the allowable maximum of 0.01 inch per foot, use an adequate number of bearings and place them immediately adjacent to the points of power input and take-off.

Machines of all types probably are driven more often through a belt than in any other way. When a belt is of the proper type for the atmospheric and service conditions, it is an efficient power transmitting medium. Nevertheless, under some conditions belt drives can be

the cause of considerable loss of power. For example, use of the wrong type for the atmospheric conditions will result in short belt life, loss of power, and high maintenance costs. A belt that is too small, too little arc of contact, small pulleys that have too low coefficient of friction, are all likely to result in excessive slippage and shorter belt life. Furthermore, the usual remedy is to increase the belt tension, which increases bearing friction and wear.

Belt selection should be based on a study of each case, but certain principles have broad application. It is better to select a belt that is too large rather than too small. A belt that is badly overworked is certain to have short life and will probably cause waste of power all the time it is in service. The thickness of a belt should be governed by pulley diameter and speed.

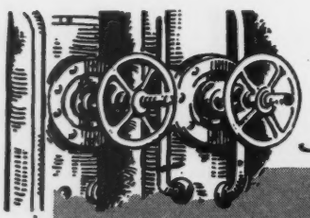
Speeds to Fit Needs

The most efficient belt speeds range from 1,500 to 3,500 feet per minute. Below 1,500 feet per minute heavy belting is required in proportion to the load carried, and above 3,500 feet per minute centrifugal tension causes loss of pulley contact, slip, and power loss.

At the higher speeds windage losses of belts and pulleys are far from negligible, but much smaller proportionately at normal or medium speeds. On a 50-hp. drive the windage loss will range from 1 to 3 horsepower at a belt speed of 5,000 feet per minute, depending, of course, on the pulley centers and the type of pulleys.

Belt tension is another matter that may cause trouble and loss of power, and hence needs watching. Just enough tension should be put on a belt to enable it to carry its load with negligible slip (1 to 3 per cent).

With flat-belt short-center drives it is usually necessary to provide means for maintaining proper belt tension and/or increasing the arc of contact.



Power costs are still controllable costs. There are minimum wage rates fixed by law. There are maximum hours. But no law has fixed minimum coal piles or maximum efficiency. In power costs lies one of industry's big opportunities to reduce expenses

Idler pulleys have long been used for this purpose, and when properly applied give excellent service. The pivoted motor base has also come into wide use for maintaining the desired belt tension. This is accomplished by balancing a part of the weight of the motor against the belt.

Cheap dressing compounds cause premature belt destruction, excessive slip, and power loss. Use only dressings furnished by the belt maker or a reputable manufacturer of such materials.

Suitable types of pulleys are available for every power requirement. Maintenance costs and power losses increase when the wrong type is employed. The pulley face should be wider than the belt, and the crown of the face normal, to avoid premature belt destruction. Above 3,500 feet per minute the pulley should be balanced, regardless of type.

Design of pulleys for high-speed operation should be such as to minimize windage.

The loose pulley of a tight-and-loose set is a constant source of trouble if improperly bushed and poorly lubricated. Use automatic oil or grease feed.

Variable-speed transmissions are commonly used to obtain varying speeds from a constant-speed source. Lubrication is the chief maintenance attention required. If this is neglected, or improperly done, bearing wear and increased power losses will follow.

Speed reducers are frequently connected between the motor and driven shaft by couplings. In order to avoid misalignment of shafts, motors and reducers should be mounted integrally on a cast-iron or welded steel base and ample outboard bearings provided if the load is heavy.

Lately, geared motor reducers have been introduced. In these units the gear and motor housings are integral.

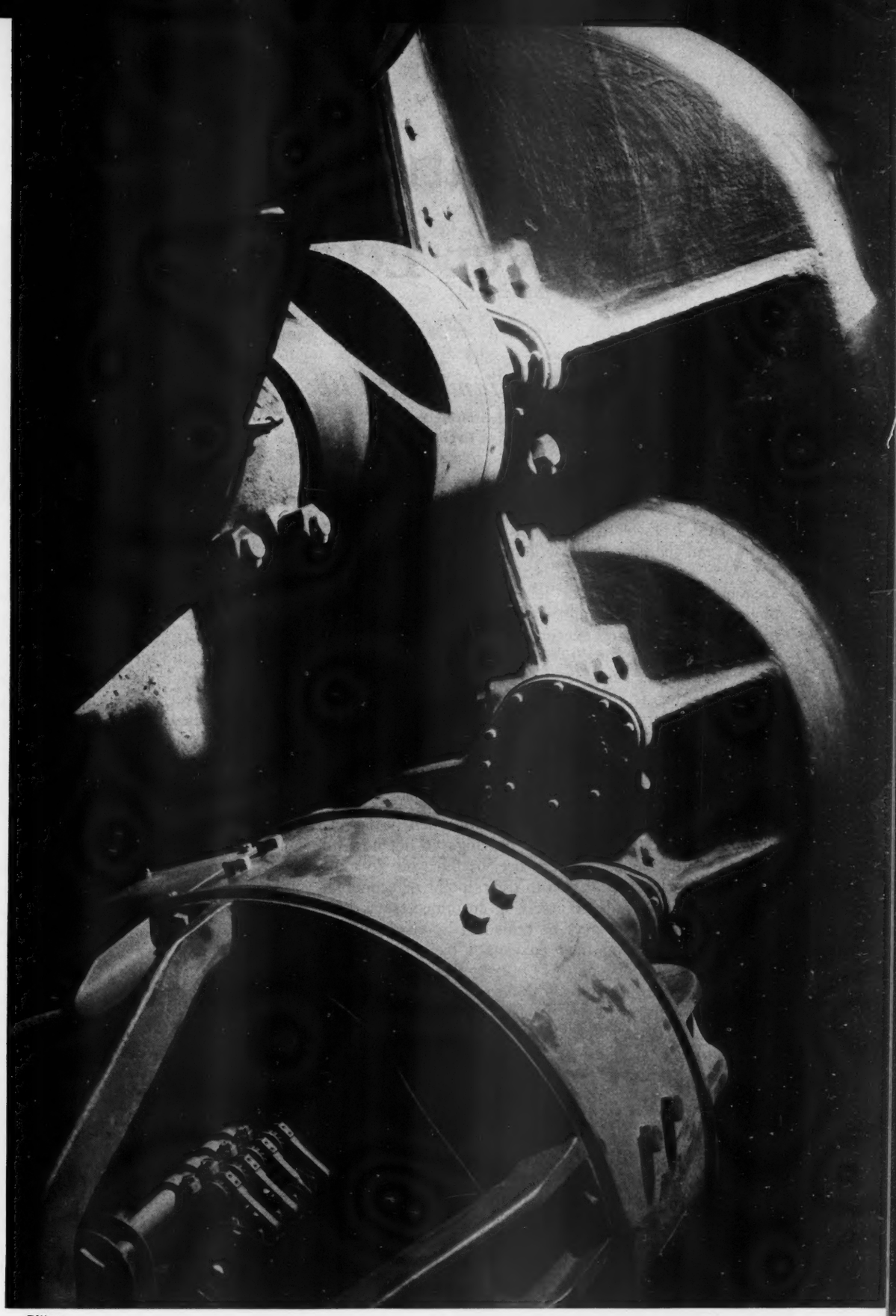
Speed reducers are usually fitted, at least in part, with anti-friction bearings; lubrication is by splash or circulation systems. Changing the oil at suitable intervals and checking the height of the oil level will keep power losses at a minimum.

Chain drives find many applications in industry, particularly where a constant speed ratio must be maintained between two shafts, or large amounts of power must be transmitted.

Lubrication Is Always Important

Life and maintenance cost of power chains depend on using the correct type and size, on accurate alignment, and on efficient lubrication. Overload results in pitch elongation, with the possibility of the chain riding the sprockets. Poor lubrication causes excessive wear. Roller chains, operating at low speeds, should be lubricated manually with a suitable grease. For normal and high speeds, roller and silent-type chains should be inclosed and lubricated by a splash or pressure system.

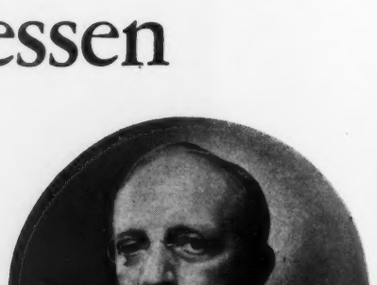
To prevent power loss and high maintenance cost on friction clutches: (1) Select a clutch rated at least 25 per cent higher than the power to be transmitted. Stresses on the mechanism depend largely on the manner in which the clutch is operated; (2) adjust frictional surfaces properly; (3) use the automatic method of lubricant application, rather than the manual, for the sleeve of a friction clutch.



Rittase

¶ There is inevitably a loss of power in transforming electrical into mechanical energy and distributing it to the machine. That loss can be kept low

What Lubrication to Lessen Power Losses



William F. Parish

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Chairman, Lubrication Engineering Committee, A.S.M.E.
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WOULD you believe that the wrong kind of oil can increase the friction of a bearing? Believe it or not, that is what can and does happen frequently. Necessity for lubricating machinery is so obvious that no one would think of questioning it. In many instances, plant executives likewise do not think of questioning the quality of the lubrication accorded to the equipment in their charge, which is a very important matter from several standpoints. In view of the great variety in the sizes, designs, and speeds of bearings, the wide range of operating conditions, and the many different lubricants and methods of applying them, it is not surprising that lubrication of plant machinery may be good, bad, or worse.

Not every user of machinery knows when he is getting poor lubrication. Machine bearings do not have to heat up to the trouble point, score, or burn out to indicate poor lubrication. From the standpoint of economy, poor lubrication manifests itself by an unnecessary drag on the machines that may be remedied by changing the lubricant. This drag may be caused by one or more of these five conditions: (1) Irregular feed of oil; (2) oil too thick; (3) oil too thin; (4) oil of the proper consistency, but develops deposits that interfere with lubrication by destroying the oil-carrying properties of bearing metals; (5) oil of the proper consistency, but lacks power of adhesion (oiliness) without which it will not lubricate properly. In every case the oil may be the best of its kind, bought at a high price.

They Like to Use Heavy Oils

It is strange but true that nearly every man who lubricates machinery as a daily duty will, if left to himself, use the heaviest-bodied oil that he can obtain. Probably the reason for this is that such an oil will last longer and less attention to the machine is required.

Much trouble was experienced in one plant with the bearings in polishing jacks. The shafts are driven at 3,360 r.p.m. and were lubricated with a light grade of lubricating oil. One or more bearings burned out each week. Bearing temperatures averaged 148 deg. F.

Contrary to recommendations, a heavier grade of oil was tried in one of the bearings. The temperature soon rose to 156 deg. F., and the machine was stopped.

Upon substituting a light-bodied oil of more film strength the temperature dropped to 120 deg. F. There have been no more bearing failures. The lighter oil costs somewhat more than the grade previously used, but there is a saving of about $250 a year in bearings.

Proper lubrication can be obtained only by the use of lubricants and methods of application that will reduce the power requirements to the lowest practicable point and still protect the bearings at all times. It must also be accomplished with the minimum amount of oil.

When a factory is changed over from poor to proper lubrication a power reduction of from 5 per cent to as high as 30 per cent will be indicated. If the speed of the machines controls their production, there will be a greater production per day during the time when the mill temperature is the same under both conditions of lubrication. This increase in production may range from a fraction of 1 per cent to as high as 6 per cent. In every case there will be an increase in the production per month because the machines come up to speed faster.

Changed Oil, Saved $4,925

Increase in production from this cause may be as high as 12 to 15 per cent in some plants, especially in those making their own power and during the cold weather. In severe cold weather poor lubrication in some kinds of plants causes heavy losses in production. In fact, some kinds of machinery can be operated only with great difficulty when exposed to extremes of temperatures, as commonly lubricated. In the same plant, when suitable lubricants are used, close to summer schedules of production can be maintained.

Too heavy lubricants, that are too cold, can cause serious difficulty, because they will not circulate freely, a matter that depends almost entirely upon the method of application.

As an example of savings that can be realized through proper lubrication, the experience of a Massachusetts cotton mill is significant. Changing the kind of lubricating oil effected a saving in power costs estimated at $4,925 annually, which is somewhat more than the total cost of the lubricants used. A 7 per cent reduction in the yearly power bill, from $70,458 with the old oils, to $65,533 with the new, followed a reduction in power

requirements from 33.025 kw. to 31.50 kw. on four breaker and five finishing pickers. There was a corresponding reduction in the spinning department.

In many plants machinery is allowed to run much under capacity, consuming too much power and causing too high maintenance charges, due to lack of interest by the management in what is called the "unnecessary frictional load." On some machines, when run idle, this additional and utterly useless load may be as high as 60 per cent of the power required for full production.

Several steps must be taken in order to establish the proper lubrication. The order that these steps should follow probably does not matter greatly, and in any event will be considerably influenced by previous practice and local conditions in the plant. However, one of the first steps is to make one man, perferably the plant engineer or some one who has had the requisite training, responsible for the lubrication of all equipment. Closely following this step, an adequate routine covering the inspection and lubrication of all bearings should be put into effect.

The Fewer Grades the Better

Selection and standardization of lubricants and methods of application is one of the most important undertakings. In most plants of any size the common tendency is to use too many kinds and grades of oils and greases, so that waste and confusion are almost inevitable. A systematic approach to this problem will involve making a lubrication survey of all plant equipment. Data taken should include: Department, kind and number of machines, lubricants used, and methods of application; frequency of lubrication; quantity of lubricant used; type and condition of bearings.

Bearings should be further classified as (1) grease lubricated; (2) oil lubricated, where the oil is applied by hand, wick feed or other types of oilers with which no attempt is made to use the oil over again; (3) oil lubricated by rings, splash, or circulating systems, in which the oil is used repeatedly. Choosing the correct lubricant for each bearing or kind of service is not altogether a simple matter. Valuable assistance can, however, be had from most of the large manufacturers.

In many instances the advisability of changing from oil to grease lubrication, or vice versa, should be carefully studied. Such changes have often resulted in worth-while savings or other advantages.

From the standpoint of reducing loss of power through unnecessary bearing friction, an effort should be made to use lighter rather than heavier oils. There are many instances in which the replacement of a heavy oil with a lighter one has markedly reduced bearing temperatures and, of course, power consumption. A pretty safe rule to follow is: Never use an oil that is heavier than necessary to protect the bearing adequately. Too heavy an oil is likely to cause some heating; certainly it increases power losses.

Reduction in the number of kinds and grades of lubricants used is likewise an important objective. A study of lubrication requirements will usually show that a small number of grades of oils and greases will meet every condition.

Methods of applying lubricants are almost as important as the materials themselves; sometimes more so. Antiquated or inadequate equipment can be the cause of high labor expense, waste of lubricant, unnecessary bearing trouble, and spoilage of material. Systems available for centralizing oil or grease lubrication, as well as efficient devices for individual bearing application, will do much to reduce or eliminate these wastes.

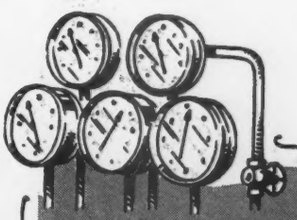
Three Simple Things to Do

After selection of suitable lubricants and lubricating devices, three simple but necessary things remain to be done. They are:

1. Issuance of standard instructions to oilers, covering the kinds and grades of lubricants to be applied to the machines under their care, with the amount, method of application, and any precautions necessary.

2. Establishment of a central lubricant dispensary. In medium- and small-sized plants the common practice of keeping lubricants in several different places and allowing anyone to help himself as his needs or fancies dictate, is certain to result in waste or spoilage of lubricant and more or less misapplication, to say nothing of constituting an unnecessary fire hazard. Putting the handling and dispensing of all lubricants under the charge of a responsible man in a conveniently located, fireproof storehouse will correct these conditions and help to maintain the close supervision that should be exercised over lubrication.

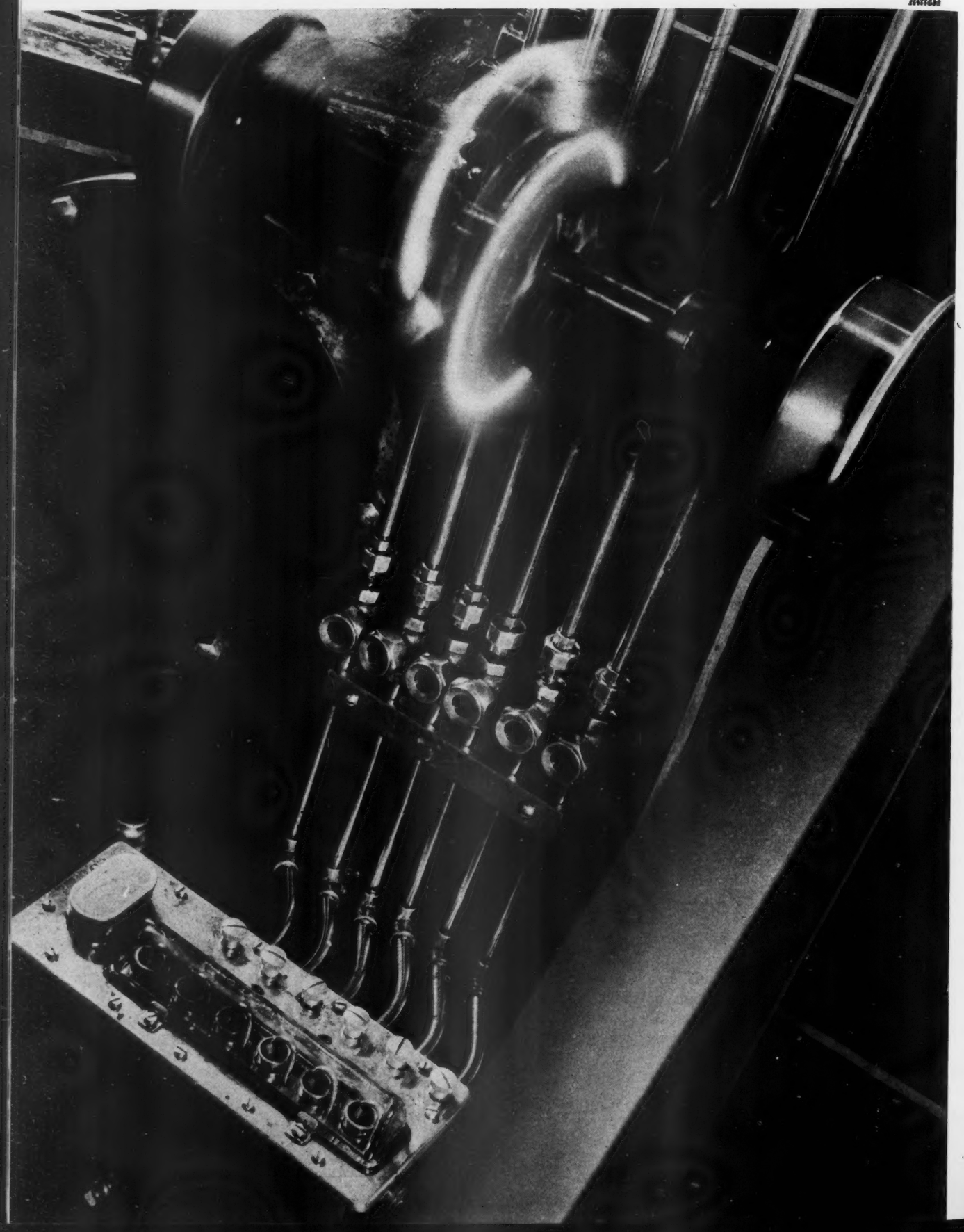
3. Maintenance of accurate records of the distribution and consumption of all lubricants. Such records will help to prevent waste by making it possible to account for all material received. Furthermore, checking the records of consumption will at once show any marked increase or decrease in usage and thus serve as a warning that investigation is needed.



Power wastes become net profits only when management understands power problems—which are here arrayed that they may be seen and recognized and understood. The "Power Loss Check Chart" is *Factory's* graphic presentation of controllable wastes

Incorrect lubrication, where thousands of bearings are concerned, increases friction losses to the point where they affect power bills adversely

Ritter



Which Motor, *Which* Control to Check Power Wastes

George H. Hall
Consulting Engineer
New York

WHEN a current of 746 watts is applied to an electric motor it should deliver 1 full horsepower to the machine which it drives, but it does not. It delivers only a fraction of 1 horsepower, for the simple reason that no apparatus yet made is capable of operating at 100 per cent efficiency. In the motor, and between it and the machine, occur losses due to the dissipation of heat in the windings, friction in the bearings, slip and friction in the belt, chain, or gears of the drive. An efficiency of about 75 per cent for a drive, including motor and transmission losses, is a good average, although with direct-connected motors it may be somewhat higher at times.

Engineers and management are interested in getting as nearly as possible 1 horsepower of productive work for every 746 watts of current paid for. This over-all efficiency depends on a number of factors which, if subjected to careful analysis, will often reveal opportunities for improvement.

Watch Those Loads

Of these factors some are tangible, such as motor efficiency, power factor (with alternating current), and efficiency of the drive connecting motor and machine. Other factors, intangible but of equal, sometimes greater, importance, are those of control, safety, and maintenance attention required. One may also include first cost, since a drive of extremely high efficiency may cost more than is warranted by the existing conditions.

Motor efficiency should be carefully considered when purchasing new motors. With existing drives this factor presents but small opportunity for improvement, since it can be obtained only by changing the motors. However, standard motors of all reputable makes have comparatively high efficiency so that such a change is seldom warranted. The important point is to see that the motor is working under load conditions that will give the highest efficiency. On the efficiency curve this point lies between three-quarters and full load. Motors running continuously at lower loads should be replaced.

Other factors of the drive should be analyzed before deciding upon a change, since an improvement of a few points in motor efficiency may be offset by lowered efficiency of other factors.

When a direct-current motor operates at variable speed obtained by armature control there is considerable current dissipated as heat in the resistor used for reducing the speed. This condition can often be improved by using field control. If a slip-ring motor is used for speed variation the losses in heat dissipation are not so great as with armature control; nevertheless, a multi-speed motor can often be used to advantage.

Again, maintenance costs can often be reduced by the use of some kind of motor that is better suited to the operating conditions than the standard, general-purpose design. Thus, where much dirt and dust are present over-all efficiency will be increased by the use of a fully inclosed, fan-cooled motor.

With alternating-current installations power factor should be carefully watched since it gives more opportunity of improving over-all efficiency than does motor efficiency alone. Power factor represents the relation between the working current and the magnetizing or workless current. A motor requires practically the same magnetizing current at all loads; hence the reason for changing continuously underloaded motors.

Another method of improving power factor is by the use of capacitors at the terminals of induction motors. This method is especially valuable for motors at the end of long lines, where the line drop is considerable. Reducing the current that the line must carry provides higher voltage at the motor terminals. Capacitors may also be used to raise the power factor of motor groups.

Leaks in Over-All Efficiency

In any investigation looking to the improvement of plant power factor, consideration should be given to the use of synchronous motors having a leading power factor of 90 per cent. Their cost is materially lower than that of 80 per cent power factor motors.

One of the largest leaks in the over-all efficiency of motor drives is in the transmission of power from the motor to the machine it drives. In general, motors are high-speed machines, whereas most machinery is

operated at low speed. Centrifugal pumps and blowers, which may be direct-connected, are typical exceptions but production machines, machine tools, and so on, are likely to demand driving speeds not exceeding 600 r.p.m., oftentimes lower. It is, therefore, usually necessary to employ some sort of speed motor between motor and machine, or use low-speed motors at higher cost.

The most common type of speed reducer is the flat belt running over pulleys; V-belts, chains, and gearing, are other well-known forms of speed reducers.

A geared type of motor in which the gear reduction is built into the frame has recently come into prominence. It is compact and efficient. From the standpoint of comparative cost, a motor wound for low speed may be used for direct connection at driving speeds of 600 r.p.m., or above, whereas below this speed the 1,800-r.p.m. motor with gear reduction, will be less expensive.

When a Controller Is Efficient

The motor controller is frequently overloaded in the consideration of efficiency, since its primary function is simply to close and maintain a circuit, or to arrange a desirable combination of leads to the motor. Controllers do, however, present problems affecting the over-all efficiency to a very large degree. A controller, to be efficient, must protect the motor against overload and at the same time prevent its stopping from temporary overloads that will not cause injury.

Controllers should afford low- or no-voltage protection to prevent unintentional starting after the current has been cut off and then restored. As with overload protection, it is desirable that the motors continue to operate if the current failure is but momentary; so the time-delay no-voltage device should be employed.

To secure the highest control efficiency phase protection should also be provided. This will stop the motor upon failure of any phase of the two- or three-phase circuit upon which it is running; also, in the event of phase reversal. Phase failure results in the motor endeavoring to carry its full load on a single phase. If the fuse or overload relay protecting this phase fails to respond to the increased load, the motor winding will be burned out.

On phase reversal much damage can be done to the machinery or product by reversal of rotation. Losses from this cause may very easily exceed the cost of the protective device.

Loss of over-all efficiency due to neglect to keep control equipment up to date is well illustrated by a recent case, wherein a plant operating 15 motors ranging from 25 to 150 horsepower was suddenly crippled by the burning out of one of the 150-horsepower motors. Investigation showed that a defective fuse had failed, putting the motor load on a single phase. The control had no protection other than the line fuses.

When this plant was installed about 20 years ago the equipment was the best obtainable, and it is no criticism of the motor and control builders that this accident occurred. During the past 20 years, however, great improvements have been made in control apparatus. A survey revealed that the remainder of the 20-year-old motors are still in reliable condition, but that all control equipment was obsolete; so it was replaced.

Protection Against Shutdown

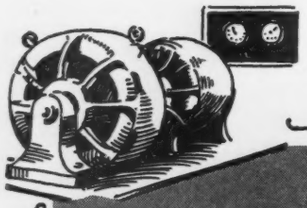
This change did not reduce the current required by the motors, but the protection from accidental shutdowns and the saving in maintenance cost certainly increased the over-all efficiency.

Investigation of the motor controls in any plant may disclose some of the best opportunities for increasing the over-all efficiency of a machine or plant.

One such opportunity is found in the substitution of magnetic starters and controls for the manually operated type. With these starters, operated by a push-button, the motors may be started or stopped at any point most convenient for the workman. Time thus saved is a considerable factor in over-all efficiency. Magnetic starters for motors that may be thrown across the line cost little more than hand starters.

Substitution of automatic starting compensators for the manually operated type may need careful consideration, since the cost difference is considerable. Conditions may not always warrant this increased cost, but at times it will be far overbalanced by the saving in time. In any event, compensators should be equipped with Stop buttons. They are standard equipment on most of the latest types, and can usually be fitted to old compensators.

The ability to stop compensator-controlled motors from a remote place is at least a 50 per cent approach to the advantages of full magnetic control. Use of Stop buttons is not limited to a single point; any number may be installed in series so that the motor may be stopped from numerous convenient points. Ability to stop a motor at once, without going to the compensator, which may be located in some remote position, is an important safety factor, since it may prevent injury both to product and to workmen.



Power costs in many plants represent the largest single chance to make further manufacturing economies. The responsibility for power savings—from recognizing that the opportunity exists to doing something about it—is management's

Factory Management
and Maintenance

A consolidation of *Factory and Industrial Management* and *Maintenance Engineering*

L. C. MORROW, Editor

October, 1934

Wanted—Industry's Voice in Bettering NRA

NOW IS the time for industry to become constructively articulate. Patience, indulgence, and forbearance for the NRA experiment have been commendable and necessary, still are desirable to a considerable extent. But, with 15 months of revealing experience already become history, it is obvious that there is no need to prolong uncertainty.

There *is* recovery. Business *is* better. But, by the admission of its own representatives, business is not as good as it would be if more were known about what is ahead. For some of these uncertainties business itself is responsible by having written the wrong things into codes; for the remainder government is responsible.

However, nothing is to be gained by fixing the responsibility. The fact of immediate importance is that business and industry have regained perspective, can do much to effect the intended partnership of management, labor, and government. While the NRA set-up is changing, and before the new Congress convenes is the time to act.

Upon what matters should industry declare itself? It seems to us that the most important ones are limitation of production, price fixing, the profit system, labor policy, self-government in industry. Let us consider them briefly.

Restriction of production is not conducive to prosperity. An increasing, not a decreasing, standard of living is a necessary adjunct of busy factories. The needs and wants of people are far from satisfied. They can approach satisfaction only as the commodities needed to fill them are manufactured in such quantities and at such low cost that very wide distribution is possible. Allocation of production must accompany restriction. Allocation places a premium upon inefficient management, raises costs and selling prices.

Price fixing, except in a few instances where conservation of natural resources is involved, has a strong tendency toward the same undesirable results that are brought about by restriction of production.

Abandonment of the profit system (socialization of industry) would destroy the incentive that can bring about a standard of living not hitherto approached. It would eliminate motive for capital investment; the fear of it has already stagnated that activity.

A labor law that does not mean what it says is worse than no law. In our opinion 7(a) does not say that a majority shall represent all. The present labor board has ruled that it does. Is this ruling to replace the ruling for proportional representation given the automotive industry? How can there be labor-management peace until this law is rewritten to say something that can be interpreted only one way?

Self-government in industry that will bring about cooperation to establish and enforce rules of fair competition and conduct looking toward the public welfare is beneficial and will contribute toward business stability. But administrative orders, interpretations, and changes that nullify true self-government create confusion and destroy confidence.

SO MUCH for five important matters that it seems to us industry can agree upon and do something about. There are others concerning which industry and business should have assurance—the federal budget, value of the dollar, agricultural policy, continuation of public works, government operation of idle plants.

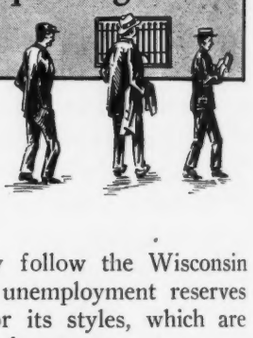
It is not enough merely to oppose what has taken place and what is going on, with the implication that there must be a return to exactly what was. Conditions have changed. The original intent of NRA was to everyone's advantage. The situation today is that there has been too much going afield, too much mixing of reform and recovery, too much of bureaucracy.

Industry and business can offer a substitute program that will be corrective, constructive, progressive. To do so is an obvious obligation.

Unemployment Insurance? It's Coming

Arthur Van Vlissingen, Jr.
Contributing Editor
Chicago

Make up your mind to that. The big question is what kind? Wisconsin manufacturers—who didn't want any, but got some all the same—have had just enough time to reach several conclusions. Impending legislation makes them especially important now to factory operating men



WISCONSIN employers did not want unemployment insurance made compulsory. They got it just the same, on last July first. Now that they have it, they are beginning to wonder if it may not possibly have some advantages to employers, employees, and the general public, provided that the proper type of legislation be carefully chosen. Their attitude is well summed up by the president of a large manufacturing corporation:

"We do not think unemployment insurance or reserve legislation either desirable or advantageous. But if we must have some, then we think the kind we have is the least objectionable and likewise is the type most likely to bring about the social benefits for which it was designed."

Mind you, not every employer takes this view. Some last-ditchers maintain that unemployment insurance is unemployment insurance, and that any choice between two types is about like choosing which of two types of Asiatic cholera you will have. Others whose voluntary plans were already in operation feel these were better for their own employees than what is now forced upon them by law. There are infinite variations in viewpoint, which need not be detailed here; this article does not attempt to speak for any one Wisconsin employer's personal credo. Instead, it purposes to set forth the average temper of a large number of Wisconsin manufacturers individually talked with, and to quote—without names, in the interests of candor—a very few of them.

Typical attitude of the average employer in Wisconsin is this: When it became inevitable that some unemployment insurance law would be passed, he threw his weight behind the plan eventually adopted. He still doubts its efficacy, but hopes it will work as its advocates say it will—and as, to his surprise, he has seen several other plans which he has opposed in the legislature work out well in practice—notably the first workmen's compensation act in the United States, which not only produced all the beneficial results claimed for it, but also became standard throughout industry.

Our typical Wisconsin manufacturer believes that unemployment insurance will very soon be imposed upon all American industry. He is praying that any other state or federal legislation may follow the Wisconsin pattern of individual company unemployment reserves rather than turn to Europe for its styles, which are pooled reserves—in other words, insurance.

Why? well, he has been so long a student of the theory of unemployment benefits (because the first Wisconsin bill was introduced in 1921, and the subject has been under his earnest examination ever since) that he can give the average university economist three textbooks and a reference shelf, and still know twice as much about it. He sees in the Wisconsin system some points which he thinks give a fair chance of good results, whereas he sees in the European plan only eventual disaster. (If you encounter the term "Ohio Plan" in connection with unemployment insurance, it is practically synonymous with "European Plan." The state of Ohio has at this writing adopted no laws in this field, but the European plan has been so strongly agitated in Ohio that the state's name is often associated with it.)

Wisconsin Law Provides

Briefly summed up without technicalities, the Wisconsin compulsory unemployment benefit law provides that each employer of 10 or more people shall pay into a reserve fund 2 per cent of his monthly payroll until the amount in his reserve fund equals $55 per employee who earns less than $1,500 annually; thereafter, 1 per cent until it totals $75 per such employee. At $75 no further contributions are required until withdrawals deplete the

fund or until some other circumstance, such as an increase in total payroll, makes monthly contributions once more mandatory to bring the fund up to the legal level.

The employee earning less than $1,500 who becomes unemployed is eligible after a 2-week waiting period to weekly benefits calculated in accordance with his wage rates and length of service, but in no case over $10 per week, nor more than 10 weeks' benefit in any one calendar year, nor more than 13 successive weeks.

Under the Wisconsin law, the employer makes his monthly payments (plus $\frac{1}{10}$ of 1 per cent for administration) to the State Treasurer, who holds them in a separate account for each employer.

Two other options may be exercised, however. And these are important, since practically all Wisconsin employers have chosen one of the options.

Of these options, one is to guarantee to all employees in the eligible class 42 weeks' employment of not less than two-thirds the hours normally worked—this guaranty subject to approval by the Industrial Commission, which is not disposed to approve this plan for any except financially substantial employers.

The other option is the adoption of a voluntary plan, which must also be submitted to the Industrial Commission for approval. In practice, about 80 per cent of all voluntary plans follow a form developed by one consulting service, about 19 per cent follow a form developed by the Commission, and 1 per cent are special plans. The two standard plans have been approved for general adoption and printed by the State; they require Commission's scrutiny of only the details.

Holding the Reserves

Under any voluntary plan, it is necessary to set up a separate reserve fund for holding the funds of the employer's unemployment benefit reserves. Only very substantial employers are permitted to hold these funds in a book reserve. All employers who either do not wish to hold their own funds or who cannot qualify have a choice of five other methods: (1) Trust company; (2) individual bonded trustee; (3) an improved investment association; (4) bank deposit; (5) State Treasurer.

So much for the provisions of the law. How about the prospects for its working out, and for its future development?

Typically, Wisconsin employers seem little disturbed about it as it stands. They expect that the weekly benefits will be increased to cover a longer period by the simple expedient of legislating increased size of the reserve required per employee. They will not be surprised at an increase in the weekly benefit limits, once the funds are built up to larger size.

What Employers Think

"I'm not worried about the prospects," admits the president of a large company making principally heavy machinery, "even though we should remain the only state with such a law. Frankly, I like the provisions of this law better than any other unemployment insurance I have ever seen proposed. It may exert a very strong influence upon us and all other employers to stabilize our employment—which is what the advocates of the bill claim. At the moment this is comparatively unimportant, for when we can get an order now it is for rush delivery and we have to bid on that basis, no matter how it may affect our payroll. But I know we should never have reached the number of employees we had at the peak period if this law had been in effect.

"So when the next boom comes along I believe we shall be more careful about how many men we take on. So will every other thoughtful employer. It may soften the industrial inflation, hence minimize the inevitable reaction. And I suspect that the existence of this monthly percentage contribution to unemployment reserves may be sufficient incentive to some corporations to set up an intelligent study of how to reduce all kinds of cyclical, periodic, and seasonal unemployment.

"I doubt that it will bring so great an effect for stabilization as did workmen's compensation laws for Safety First. But undoubtedly it will have an effect. And I hope this result may be greater than I can now foresee."

An officer of another company is still more hopeful:

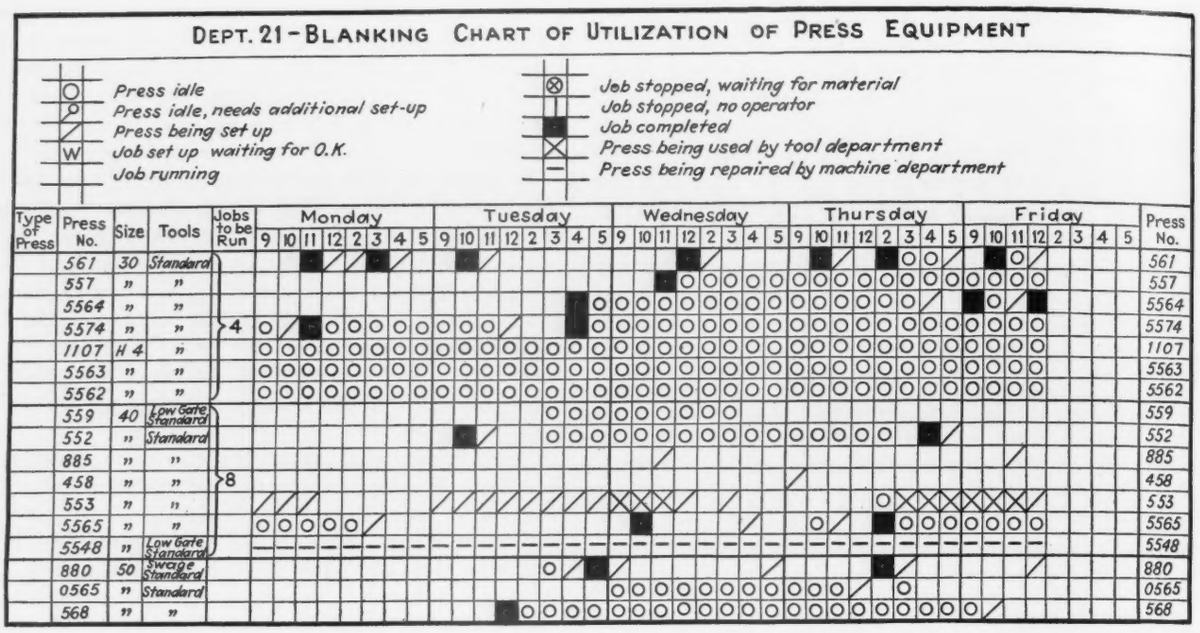
"To us it seems that this is going to force us to care for our people through all minor periods of unemployment, and through considerable parts of longer periods. Therefore we are not going to have any more such periods than we can help—and I suspect we could help a good many more than we now think we can. Our business tends toward irregular employment. But if we somehow regularize it, our contributions to the reserve fund cease and we save this money. I'm betting we regularize it. On profit margins since 1929, 2 per cent of payroll is a lot of cash.

"My brother owns a business which can operate only nine months a year because of weather conditions. He has never made any great effort to select for his season's workers men who could fit into mechanical upkeep jobs which continue the year round. Hereafter he is doing just that. He can never avoid serious seasonal unemployment, but before he quits the problem I'll bet he halves it—which means a sizable increase in annual profits over a do-nothing policy.

(Continued on advertising page 60)

WISCONSIN PLAN

1. Employers pay the bill
2. State holds the money in separate accounts
3. Employees get up to $10 a week for not more than 13 successive weeks
4. Contributions equal 2 per cent of payroll until reserve is $55 per employee, then 1 per cent until $75
5. Instead of foregoing, financially responsible employers may guarantee 42 weeks' employment
6. Or employers may adopt certain approved voluntary plans



Where's That Order?

This one-clerk control plan tells the superintendent all he needs to know, leaves the foreman free to get out production

W. C. Zinck
Assistant General Superintendent
North & Judd Manufacturing Company
New Britain, Conn.

HARNESS hardware and clothing buckles—our main products—have a simple, short manufacturing cycle. Once the articles are cast, formed on a wire machine, or blanked on a power press, they can be finished, packed and shipped very quickly.

Our originating departments, especially the blanking department, are therefore all-important in these days when customers demand and expect quicker service.

In point of numbers the 52 presses in our blanking department were always adequate for routine production. However, because of the department's somewhat haphazard growth, delays frequently occurred because orders piled up on comparatively few machines. In any blanking room poor supervision and lack of coordination with the tool, maintenance, purchasing, and production departments will cause avoidable delays.

The first move in correcting this situation was a thorough housecleaning, which made the department the tidiest in the factory. Its personnel has kept it so ever since.

Auxiliary equipment was checked next. Some of the improvements made were better-designed coil stands, movable scrap boxes that could be handled with lift trucks, a converted tiering machine to handle heavy dies, movable work benches for the toolsetters, additional rack space for tool storage, and a system for checking the location of all tools.

The presses themselves were in fair shape at the time, and it was felt that the recently installed maintenance control system (see June, page 274) would better their condition as time passed. It was therefore decided that at that time no extensive and costly standardization program to make tools and presses more interchangeable would be necessary. The successful operation of the production control plan to be outlined has justified our belief that existing press capacity will handle our normal volume satisfactorily.

In the matter of supervision and coordination our problem was to supplement the practical ability of the foreman. He has a remarkable memory for tool and press characteristics, and is an excellent toolsetter, but to facilitate closer department control, a "Chart of Utilization of Press Equipment" was devised to enable the

Figure 1. **What presses are idle, and why? This chart, with its up-to-the-hour record of operation, answers such questions. A similar record is kept to show exactly which product each press is working on, when the job began, when it ended**

BLANKING ROOM REPORT

10 A.M. Mond

Future Orders

Harness 21 T. & H. 2 Belt 1

Material at Warehouse Total 6

Waiting for Material Total 30

Harness 15 T. & H. 7 Belt 8

Material in Dept. – Waiting on Tools Total 19

Materials & Tools O.K. – Waiting to be Set Up Total 22

No. 30 Press 1 No. 40 Press 5 No. 50 Press 2

Nail Machines 7 Hand Feed 4 Special –

No. 6 Baird – Baird Transfer 3 N. B. Mach. Transfer –

D. A. Transfer – Blank & Draw –

Orders Running Total 20

Harness 7 T. & H. 3 Belt 10

Orders Stopped Running – Press Held Total 5

No Operator – Press Down 5 Tools Down –

GRAND TOTAL 126

Figure 2. From the production control board, the superintendent and his assistant can at once tell the status of every order in the blanking department. The accompanying report gives them a complete picture of what is going on. The order tickets, shown actual size, are moved by the department clerk to indicate progress of the job

general superintendent to check him on the internal operation of his department. Inter-departmental co-operation is assured by the production control board, described below. Tool data are correlated on "Tool and Stock Cutting Record Cards" and an inspection and repair routine insures that the tools will be kept in condition to be run at a moment's notice.

Figure 1 shows the utilization chart. From its up-to-the-hour record of operation, the superintendent is warned of conditions that need improvement. It answers such questions as: How are the presses loaded? What presses are idle, and why? Is additional help warranted? Has press No. X, with several "back orders" waiting on it, been repaired yet? Are the toolmakers quick in setting up new jobs? Are the production men scheduling the longest possible runs? And so on and on and on.

Ten symbols on this chart define the uses of the presses sufficiently for our purposes. In practice, two charts are used, clipped one on each side of a checking board. One chart has the symbols on it; the other, at the corresponding places as to press and time has notations explaining the conditions indicated by the symbols, such as "crankshaft broken," as the cause of a machine repair. The jobs ready to be run are noted from the production board and brought up to date each morning.

From such daily visual pictures of actual conditions, the superintendent is able to watch trends, such as percentage of down time for machine repairs; the production manager can spot check the short runs; and the management, from the average loading indicated for the several classes of presses, obtains information as to the need for additional equipment and similar data.

What's Holding Up That Order?

The production board, Figure 2, answers the universal question: What's holding up that order? Colored tickets, suitably placed in horizontal slots, tell at a glance the status of every order in the department.

The type of a certain job is indicated on this board by the color of the ticket representing it. Red stands for harness, white for belt, green for what we call "T and H" goods. The ticket's length gives an indication of the *size* of the order. The smallest ticket indicates up

DEPT. 21-BLANKING. TOOL AND STOCK CUTTING RECORD

DIVISION	SIZE	ARTICLE NO.	ARTICLE	PART OF ARTICLE
BELT	5/16	6032	BUCKLE	FRAME

MATERIAL	THICKNESS	WIDTH	SPECIFICATIONS	STOCK	POUNDS OF STOCK TO MAKE 100 GROSS	GROSS WEIGHT	"CIRCLE" FIGURE
BRASS	.040	3/4	#1-HARD	COIL GRAMP	119	.407	2.45

LOCATION OF DIE			TYPE OF DIE	TYPE OF PRESS	PRESS NO.	HOW FED
FLOOR	SECTION	SHELF				
1	11	1	PIERCE-BLANK-FORM	SPECIAL 50		AUTOMATIC HAND

DATE ORDER STARTED	DATE ORDER COMPLETED	TOTAL GROSS BLANKED	DATE SENT TO TOOL ROOM	DESCRIPTION OF REPAIRS REQUESTED	DATE RETURNED FROM TOOL ROOM	DATE TO VAULT O.K. TO RUN
1934	1934					1934
1-3	1-4	100				
1-29	1-31	200				
2-14	2-15	200				

DEPT. 21-BLANKING. TOOL AND STOCK CUTTING RECORD

DIVISION	SIZE	ARTICLE NO.	ARTICLE	PART OF ARTICLE
BELT	5/8	6031	BUCKLE	FRAME

MATERIAL	THICKNESS	WIDTH	SPECIFICATIONS	STOCK	POUNDS OF STOCK TO MAKE 100 GROSS	GROSS WEIGHT	"CIRCLE" FIGURE
BRASS	.050	11/16	#1-HARD	COIL GRAMP	135	.29	3.45

LOCATION OF DIE			TYPE OF DIE	TYPE OF PRESS	PRESS NO.	HOW FED
FLOOR	SECTION	SHELF				
1	11	7	PIERCE-BLANK-FORM	NAIL		AUTOMATIC HAND

DATE ORDER STARTED	DATE ORDER COMPLETED	TOTAL GROSS BLANKED	DATE SENT TO TOOL ROOM	DESCRIPTION OF REPAIRS REQUESTED	DATE RETURNED FROM TOOL ROOM	DATE TO VAULT O.K. TO RUN
1933	1934		1934		1934	1934
12-20	1-2	200	1-3	SHARPEN DIE + PUNCHES	1-15	1-18
1934						
1-19	1-22	300	1-23	SHARPEN DIE + PUNCHES	1-25	1-25
1-31	2-1	300				2-5

Figure 3. These cards tell the foreman of the blanking room and the tool foreman everything they need to know about a specific tool. For instance, No. 6031 was ground twice to get 500 gross, No. 6032 not at all. Chief reason, thickness of stock

to 99 gross, the next from 100 to 250, and so on. The horizontal slot in which the ticket is placed tells the exact status of that order.

Thus the board has slots for future orders, for orders whose material has been held up, orders whose materials are in, and orders waiting for presses to be set up. The department clerk moves the order tickets from rack to rack as dictated by the progress on the job. Although this board is primarily for the production men, it helps the superintendent to keep his departments coordinated.

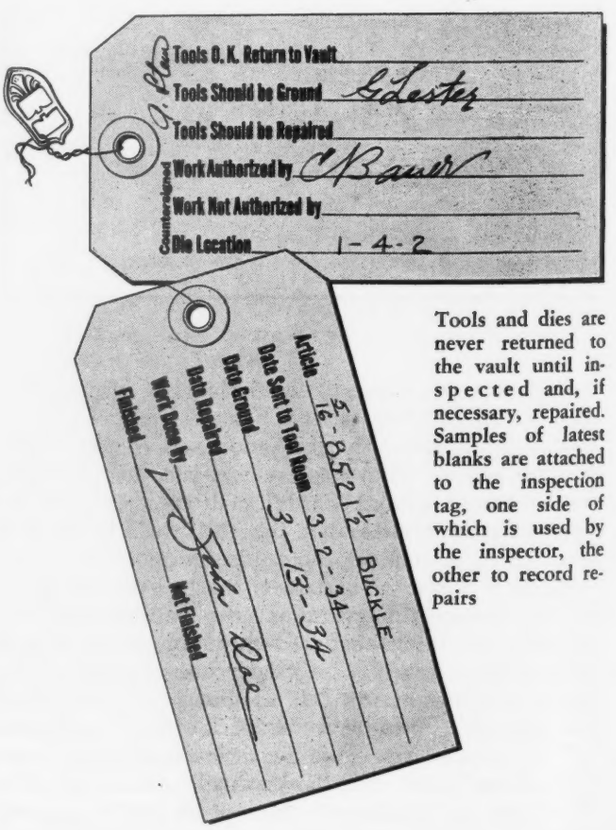
All the Facts of Tool Life

All known information about each set of tools is recorded on the Tool and Stock-Cutting Record, Figure 3. These data are of value, of course, because of the "status" information, as tool location; but the chronological record of the production from the various tools and of the repairs necessary in getting that production is of vital interest to the tool foreman as well as to the foreman of the blanking room. Improvements in tool design have resulted from such recorded experience from older tools.

Inspection and repair routine is of the utmost importance, because a wait of even a day to have tools repaired before an order can be run is serious in our short manufacturing cycle. All our tools are inspected after each order is completed, and necessary repairs are made before they are returned to the vault. This practice has improved our service and helped toolroom routine by decreasing "rush" orders for repairs. An inspection tag with several of the latest blanks attached to it, accompanies the tools when they are sent to the vault or to the toolroom.

Our shop procedure requires the foreman's signature on all requests for repairs, and that of the production man on all authorizations for repairs. We do not consider it profitable to put much labor into tools that may not be run for several years.

This system has been in operation about five months, and is a complete success. It has definitely placed responsibilities and provided indicators for controlling all the factors that contribute to production. Thus it does a good job of supervising, leaving the foreman and his helpers free to get out production.



Tools and dies are never returned to the vault until inspected and, if necessary, repaired. Samples of latest blanks are attached to the inspection tag, one side of which is used by the inspector, the other to record repairs

A Little System Goes a Long Way

Page Golsan
Vice-President, Ford, Bacon & Davis, Inc.
New York

WHEN I took over the operation of a medium-sized manufacturing plant some years ago, it was systematized—and when I say "systematized" I mean just that. You could tell to a penny how much it cost to sweep out the warehouse month before last. You could tell to a penny how much the gasoline had cost for the manager's auto last year. But you couldn't tell from the records why last year's loss had been $75,000.

Other companies in the same business and locality were making money. This one was not. The perfect records cost about $15,000 a year to keep. How much they indirectly lost will never be known.

My first request was for yesterday's figures. Sorry, but the books were never closed until the fifteenth of the following month and the costs were available only after they could be tied into the books to a penny on that date.

$15,000 Worth of Ancient History

I asked what these elaborate cost records were used for. There was no other way. They had to have them. Did anyone look at them? Now and then. Were they used to guide and control the business? Of course. Just how? That question they could not answer.

I soon found out the trouble with this business. The management's head was screwed on facing backward. The "accounting" for something that had happened was the goal. What was happening today and what was going to happen next week, were lost in the vast maze of past cost figures.

The elaborate cost ledgers they had were subsidiaries of the general ledgers, so that they could be dropped without disturbing the general books. In their stead we started a simple one-page daily report sheet that gave the facts of yesterday's plant operation. Some of it was estimated—but it was close enough for the purpose. It made no attempt to tie to the books—in fact pennies were left off. What it did give, however, was an immediate record and control.

Costs for each department were budgeted at the beginning of the month. Inventories of important items such as fuel, raw materials, and finished stock were treated in the same way. If a daily cost overshot the budget or if any inventory was out of line, a red ring was drawn around that figure. All overruns were explained on the back of the form and more particularly what was being done to prevent reoccurrence. The cure was often made before the day's record had been filled in. And did the superintendent go after those red rings!

This was real and prompt control.

The cost of this daily record was small. The timekeepers moved up their schedule two or three hours so that they finished at the end of the day rather than at noon of the next day. This they could easily do as the number of accounts was reduced from 100 to about 20 important items. The storekeepers' data and the reports from other departments on use of fuel, power, materials, and shipments had to be in at the end of the day. The men knew they had to do it, so each record during the day was completed at the time of writing. Summaries were then a matter of a few minutes.

To gather this all together, work out power costs, fuel costs, output records per unit, and like matters, was the job of a young Purdue graduate. He came to work at noon and finished as a rule about 8 o'clock in the evening.

The daily sheets certainly brought us all into intimate contact with what was going on. Plant foremen took a definite interest. Each morning they would step into the plant office to see their records for the day before. The first year's operation on the non-system basis showed a net of $100,000 in spite of a slight decline in selling price. We kept this up for four years, then sold out.

Scraps of Paper

Have you ever ridden on a ferry to lower New York City, or have you ever stood in Grant Park, Chicago, and viewed the skyline? Think of the hundreds of thousands of offices in which people are sitting, writing things on pieces of paper. Records for the file, they are, which in nine cases out of ten no one will ever look at. What is worse, in the tenth case they may "clog up the works" of straight thinking and imagination.

It seems to me that one of the biggest jobs we engineers have to do these days is to get rid of complicated methods and mixed-up thoughts. The best place for some of our costly "systems" is out the window.

A New Deal That's 40 Years Old

Kenneth Stillman
National Industrial Conference Board
New York

EMPLOYERS who still remain unconvinced of the real profit-making possibilities of an honest and sincere application of the old adage, "The more you share the richer you are," to the operation of their enterprises would do well to examine the balance sheets and the operating statements of The Pilgrim Laundry, Inc., of Brooklyn, New York, of which Mr. James E. Dann has been president and Mr. Edward H. Bancker secretary and treasurer since its organization.

Long before the terms, "industrial democracy," "employee representation," "welfare work," and similar expressions of modern trends in employee relations were in use, these men had become convinced that "Non Solum Nobis"—not for ourselves alone—was the surest way to success in any undertaking.

Today, after 40 years of constant pursuit of this ideal, The Pilgrim Laundry has become an outstanding example of an organization which has achieved success upon a basis of confidence, mutual respect, and helpfulness between the factory management and its workers.

Here, in brief, is what the employees have been and are receiving through the operation of this old "New Deal." An 8-hour day without overtime, plus four 5-minute rest periods, has been the standard for many years.

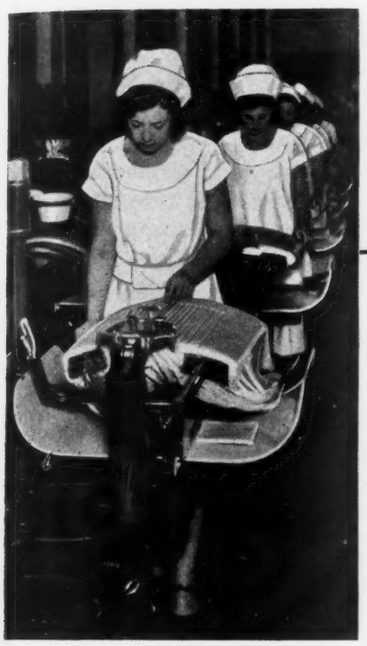
Pilgrim employees have been receiving wages higher than other laundry workers. In May, 1933, the average weekly wage of employees, exclusive of supervisors and salesmen was $19.23, while girl employees were averaging $16.49 per week. Until 1932 there were no cuts in wages or salaries. Since then there have been two cuts of 10 per cent, the last in April, 1933. In November of that year an increase of salaries and wages took place and salesmen's compensation was increased 16 per cent and that of all other employees 10 per cent. Through this advance in wages and increase in efficiency the average per capita pay of all employees (exclusive of supervisors and salesmen) has been raised from $19.23 in May, 1933, to $22.29 in February, 1934; and of the women and girl operators from $16.49 to $18.67.

The minimum wage paid by The Pilgrim Laundry to

women operators is $15, while the state minimum wage law calls for $12.40 per week. The average Pilgrim wage is 35.48 per cent higher than the average laundry wage reported by the state department of labor.

In 1931 the management announced to the employees that no one would be laid off for lack of work and, in spite of being forced to carry from 40 to 50 surplus employees during some periods of the depression, this promise is still being kept.

In 1910 some of the company stock was offered for sale to four young men who were occupying supervisory positions. These younger men eventually became officers and directors and are now, with the support of still younger men and women, sympathetically and enthusiastically carrying out the Pilgrim ideals.



In 1921 stock was offered to all employees and was bought in quantities. By 1930, employees had invested $534,000 in company stock which, at that time, had a value of $1,067,000. They had also been receiving the regular dividend of 8 per cent throughout their period of ownership. During the past three or four years, these employees have had a majority of the outstanding stock, leaving the management actually at the mercy of employees. Late in 1933, 371 employees owned an average of 77 shares of stock each.

"Not for Ourselves Alone" says Pilgrim Laundry's management; has been saying it, in fact, since the foundation of the business, finds it pays

Vacations and Honeymoons with Pay

All employees with one year of service get a week's vacation with pay each year; employees with two years or more of service get two weeks. Heads of departments get three weeks; supervisors, four weeks. An employee who gets married gets another week's vacation with pay for the honeymoon. During 1933, 503 employees received a total of 1,022 weeks of vacation pay.

For many years the company has been working toward seeing that employees should suffer no loss in their wages if their absence was due to causes over which they had no control. To that end it pays full wages for three day's absence in case of funeral in the immediate family, for jury duty, military service, and in cases of sickness extending beyond the 8-week period during which benefits are paid by the Mutual Aid Society.

Other Benefits Enjoyed

All employees are members of the Mutual Aid Society. For a contribution of one per cent of their wages for sick benefits, employees receive eight full weeks' pay for illness during any year; full salary for one week after an accident and seven weeks of pay at one-third the regular rate which is not covered by workmen's compensation; and $100 for their nearest relative at death. The company contributes a yearly sum equal to the amount collected in dues.

Other activities which Pilgrim looks upon as essential and valuable factors of the business include a restaurant where food is sold at cost, an extensive library, dressing rooms and lockers for employees, shower baths, first aid and hospital service, organized recreation. Then there are service awards, beginning with a silver pin at the completion of one year of service; gold pins when five years have been completed, and a gold pin set with diamonds for 25 years. Employees with perfect attendance for the year receive $5. For successive perfect records the annual bonus increases so that this year one employee will get $50 for his long record of perfect attendance. All girl employees wear neat and good-looking uniforms for which they pay half the cost. Color and decorations of uniform distinguish supervisors, emergency crew workers, and other special types of workers.

How has the company fared while all these advantages have been enjoyed by the employees? *Dividends have never been passed.* With no outside funds used except from the sale of stock to employees and earnings, the company's stock has more than doubled in value since 1921, when stock was first offered for employee circulation. Until 1931, each year's volume of business has been greater than for the preceding year. Company earnings even in 1931 were more than in any previous year, both in percentage and dollars. A survey of the laundry business during the latter part of 1933 disclosed that laundry business in general had dropped 60 to 65 per cent whereas Pilgrim's business was down 22 per cent.

Some of the philosophy which has been the foundation upon which this organization has been built, is best expressed in Mr. Dann's own words. Says he:

"To secure the confidence and cooperation of the employee, you must have no secrets as to salaries, wages, dividends, hours, or earnings. For 40 years officers and supervisors have constantly been on the floor telling employees exactly what problems the company faced,

(Continued on advertising page 62)

You want to know

. . . . and the editors will be glad to tell you . . . . more about the things mentioned on this page

• UNBURSTABLE is the claim made for a new abrasive wheel made in tapered segments and held together in wheel form by steel plates.

• RUBBER BELT dressing, new, merely softens the surface, doesn't penetrate like castor oil and deteriorate the body of the belt. Increases pulley grip and horsepower delivery.

• AIR CIRCULATOR for closed-cab elevators combines draftless fan with ceiling lights.

• GEARED MOTOR, new, offers "a thousand speeds" at the turn of a wheel.

• CAMERA-PROJECTOR, primarily for sales use, needs no electrical outlets, furnishes light from batteries, needs only a sheet of paper for a screen.

• POCKET SLIDE RULE takes the place of complicated arithmetic in figuring correct capacity of air filters, supplies information in half a minute.

• BEER in tin cans appears to have become a reality. It has a draught taste, or so they say, the flavor being preserved by a "keg lining."

• GREEN being a favorite color in the kitchen, a New York concern has adopted an emerald green fluted glass jar for its malted milk. When the m.m. is gone, the jar makes a good pantry-shelf container.

• PORTABLE CLEANER—1 hp. motored—blows or vacuums dirt with its 275-mile breeze, sprays paint, insecticides, any liquid or powder.

• GRINDING WHEELS made of crushed diamonds remove thirteen times more stock per minute than previous specially developed abrasive wheels in shaping and conditioning cemented carbide tools. Need no dressing. Fact is, can't be dressed.

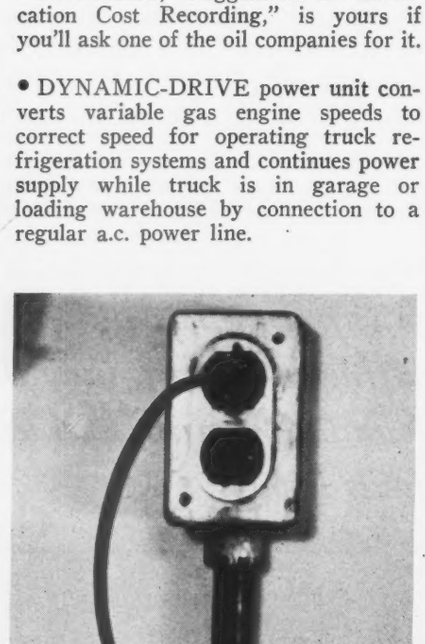
• EVEN the lowly wastebasket may profitably be redesigned. One just out is rust-resistant, has rounded stainless steel feet, heavy felt corner bumpers.

• SCREW STEELS newly developed largely eliminate the abrasive elements that tend to wear away the cutting edges of tools. No higher speeds and feeds, but longer tool life and fewer machine shutdowns for regrinding are claimed.

• LATEST tamper-proof liquor cap is really two caps. As you unscrew the outer cap, the top pops off, leaving the inner cap, a regular molded screw-cap seal, on the bottle.

• BOOKLET, "Suggestions for Lubrication Cost Recording," is yours if you'll ask one of the oil companies for it.

• DYNAMIC-DRIVE power unit converts variable gas engine speeds to correct speed for operating truck refrigeration systems and continues power supply while truck is in garage or loading warehouse by connection to a regular a.c. power line.



Voltage indicator uses foot-candle meter to turn volts into light and back to volts again. Voltage determined by reading foot-candles on meter and checking against conversion scale

• SHOVEL, closed-back type, is said to possess all the advantages, none of the disadvantages, of the welded strap, hollow back, and solid shank varieties.

• FOOT-CANDLE tables, based on the new science of seeing, propose a reduction in the toll of crippled eyesight and a conservation of human energy.

• IF YOURS is the problem of accounting for the transfer of materials and products between plants, the methods of 34 companies are revealed, six of them in detail, in a report entitled "Accounting Policies in Inter-Company Sales and Transfers."

• BLACK ZINC is ordinary zinc electrochemically treated to increase corrosion resistance.

• AUTOMOBILE keys are being dyed. By their colors you shall know which is the ignition, which is the door key. They're aluminum.

• REPOLISHABILITY tests show that a certain kid leather possesses satisfactory resistance to scuffing.

• CONSTANT SPEED camera and projector for motion-study analyses are motor driven, use 8-mm. film. Projector has a tachometer that counts frames for the operator.

• SOLDERING FURNACE, if you need one, has a ribbon burner that not only produces uniform temperature throughout the combustion chamber, but also keeps out the air and eliminates oxidation of the coppers.

• REGULAR consumption of cod liver oil, according to a recent study, will materially cut down lost time caused by colds and similar troubles.

• IF INTERESTED in the consumer viewpoint on returned goods, there's a government pamphlet on the subject.

• LIFT TRUCK, 30-ton capacity, goes where you want it to, depends not upon manual but upon power steering. A d.c. motor actuates steering wheels with a slight movement of a directional handle.

• ROTARY PLANER, portable, electric, saves many hours of costly labor formerly done by hand with jack plane or adz.

• POWER CRIMPER and sealer handles bags or envelopes of heat-sealing material at the rate of 20 to 35 per minute.

• A NEWLY DESIGNED peanut butter jar defies all the rules and regulations, looks smaller than its predecessor, sells better. Rounded contour makes it easier to get at the last dab.

Paid a Bonus in this Year 1934

and here's why

• In recognition for the perhaps intangible efforts by employees which resulted in highly tangible dollars of extra profit • • As part of a friendly management policy which insures unity, cohesiveness, and solidarity • • • To forestall any feeling that when times get better the stockholders get all the gravy

ECHOES of "the good old days" rustled faintly in the corridors of time with the September announcement by Jewel Tea Co., Inc., of the payment of a "wage extra" to all employees except senior executives. All forms of bonus compensation have been so rare during the past three or four years that this action made the front page of many metropolitan newspapers, and landed prominently on the financial page of practically every daily. Which was not, obviously, the company's motive in disbursing $75,000 to more than 2,250 employees in factory departments, offices, and the sales branches located throughout the country.

Nor was it a mere gesture to personnel. Anyone in close contact with Jewel employees recognizes that they constitute an extraordinarily solid and loyal organization, exceptionally satisfied with their employment and their rewards.

What the Motive?

What, then, *was* the motive behind this extra disbursement at a time when the gratuitous bonus had become almost extinct?

Part of the reasons were explained in the public announcement. During the first half of 1934 Jewel Tea increased its profits over the corresponding period of 1933. In dollars, this added profit amounted to $400,000. Its source was a combination of all the factors conceivably entering into such a showing—decreased waste, increased manufacturing efficiency, greater sales, absorption of increased volume of routine by existing forces, more satisfactory profit margins on merchandise, skillful buying. The wage extra was the tangible recognition by the directors and management of the perhaps intangible efforts by the employees which resulted in these highly tangible dollars of extra profit.

Other reasons for the wage extra, no less creditable to the company, were suggested by M. H. Karker, Jewel Tea's president, in discussing this broad subject:

"I believe it to be self-evident that no one can accurately determine the relative value of the contributions by men, money, materials, and management to profits. . . .

"It is still true, even in these days of the New Deal and of widespread talk of a larger share for labor, that all there is to be divided among the elements of any business is that which they themselves produce. So long as the division of what is produced is regarded as equitable and fair by those who produce it as well as by those who know of its production, so long will there be support of the present system of private ownership and so long will the professional labor agitator and radical disturber have a difficult time in making himself heard within that organization."

All of which certainly does not mean that this bonus of around $75,000 was handed out to prevent labor troubles. Rather is it part of a broad policy toward employees which has brought about a relationship that is solidly friendly after the fashion of old friendships rather than of sudden wooings. This mutual trust is considered of the utmost value to the company. Again let's quote Mr. Karker—this time from a talk which he made last summer over a telephone hook-up to all employees, assembled in the 81 branch offices of the company throughout the country:

Said the President of Jewel Tea

"You and I have undertaken the job of working together for Jewel. The progress you make is being watched by more people than you would believe. Careful check of what we do and of the results we get is being kept by banks, economists, investment services, stockholders,and competitive merchandisers all over the country. After the usual comment about the high character and unusual quality of Jewel people, there is one thing which stands out in the minds and impressions of others about us and that is our unity of interest, application, and

determination. They comment that we trust one another and are united in our faith in ourselves and in the future. I don't know of any greater safeguard or any more certain insurance of the future than this same fellowship, understanding, and cohesion."

Now we may safely generalize a bit about this wage extra so recently paid. Since the company had shown an unusual gain in profits during the period immediately past, its management felt that in all fairness this gain should be shared with the employees who had made it possible. Thus was intelligently forestalled any possible feeling among the rank and file that when times turn for the better the stockholders—like the vest in the song celebrating the fact that the coat and the pants do all the work—get all the gravy.

No Isolated Instance of Generosity

This was not an isolated instance of employer-generosity; in fact Jewel Tea executives would be the first to protest that it is not anything so paternalistic as generosity, but simply horse-sense management. Rather, this was a continuation of a policy which has held Jewel employees' wages at a high level throughout the depression since the company has managed to earn a respectable profit despite generally unfavorable conditions.

The company's attitude was stated in the telephone talk quoted just above:

"The greatest service that we can render anybody today—including the Federal government which is struggling to improve the lot of all of us—is to continue operations at a profit. We carry on our shoulders a share of responsibility to our fellow-workers, to nearly a million customer families, and to 3,000 stockholders. All of them are looking to us to protect their interests, and it is only by producing more that we have more to divide with any of them and all of them. . . .

"For years we have talked a good deal about reduction in the expenses of operation, about the elimination of waste, about improvement in our operating efficiency. Waste is a vicious thing and I want to cut out waste and inefficiency wherever they appear, but I do *not* want to reduce wages and commissions. Our object is to cut down all expenses *except* wages. If we can . . . . do all those things that eliminate the waste and reduce the cost of running the business, we will have produced more and can divide more—just as Jewel has always done. That, in conjunction with larger sales, is the most practical way I know permanently to increase our compensation."

In brief, here is a company policy predicated upon a principle to which many concerns give lip service without actually believing it. And this principle of sharing with the employees fairly has brought a response from the employees which proves the thing actually works. It is a favorite saying in the Jewel executive offices that there is no way by which you can hedge both sides of a commodity market at the same time, but there is one way by which a business can protect itself against both sides of anything that can happen—and that way is by the unity, cohesiveness, and solidarity of its people.

From the day the plan was announced, the hearty appreciation of employees has been shown in dozens of ways. Office and plant people at the Barrington, Ill., home office and plant expressed their delight to their superior officers all the way up the line; every supervisor or executive was impressed by the fact that all his people at one time or another mentioned it with genuine enthusiasm.

Comments from the Field

Likewise the comments came in from the field. Every letter or accounting report or branch inventory somehow carried tucked in with it an expression of the heartfelt appreciation of the employee who sent it in. Salesmen wrote in by the hundred, and in manner which showed there had been no prodding from above to produce the letters. They were obviously spontaneous.

Nobody can isolate the increases in production caused by any single element, yet throughout Jewel Tea plant, offices, and branches there is reported an even more enthusiastic spirit of "let's go" than before. From all of which one may conservatively deduce that even though the idea was conceived in the desire to share with employees what they had contributed to the company's excellent first-half showing, this money may come back rather soon in the form of still better profits.

Laboratory control of quality . . . .

Instrument control of power services . . . .

Inventory control of finished goods—all helped Jewel Tea earn the profit that resulted in the "wage extra" paid September 15

More Shift Schedules

1. 8-Hour Day. 40-Hour Week

One appeared last month and two others will be published in November and December

THE PROBLEM of scheduling shifts so that a man going home from the night turn doesn't meet himself coming back to work in the wee, sma' hours has been rearing its ugly head in the midst of many of us ever since the codes began to specify maximum hours per day and week.

Last month, therefore, *Factory* showed (page 386) how one plant rotates its shifts.

Here is another plan, also in successful operation, which has been worked out for 8-hour shifts, 42-, 40-, 36-, and 32-hour weeks, as well as for 6-hour shifts, 36-, 35-, 33-, and 30-hour weeks. All the schedules are alike in principle. Three will be shown—this month the one that covers the 8-hour day and the 40-hour week, next month the schedule worked out for the 6-hour day, 36-hour week, and in December the one for the 8-hour day, 36-hour week.

This type of shift schedule has these good points:

1. Repeating cycles of days off and shift changes, uniformly scheduled for all men including shift breakers. (Note that in this particular schedule each man has two weeks-ends off in seven.)

2. Regular repetition of schedule after a definite number of weeks, seven in this instance. Robinson, for example, can plan ahead as far as he likes.

3. Swinging of shifts once a week and only after a man's day or days off. The men prefer a weekly to a monthly change. The management finds the weekly change advantageous because it eliminates long stretches when department heads lose touch with men on night shifts.

4. Shift breakers are never called upon to cover more than two jobs. Their hourly rate is determined by the rates of pay for jobs broken and proportionate time spent on each. For example, a breaker who spends three days on an 80-cent and two on a 70-cent job gets 76 cents an hour.

Schedules are all based on the calendar week, but may be adjusted to any pay period. Number of jobs covered by each schedule varies with mathematical requirements. Any schedule may be applied to operations including any number of jobs, but unless the number of jobs is an even multiple of the number covered on the schedule, one shift breaker will be engaged only part time.

40-HOUR WEEK—SHIFT SCHEDULE—8-HOUR SHIFTS

Schedule repeated after seven weeks

Operator		Wk. End 10/6 S M T W T F S	Wk. End. 10/13 S M T W T F S	Wk. End. 10/20 S M T W T F S	Wk. End. 10/27 S M T W T F S	Wk. End. 11/3 S M T W T F S	Wk. End. 11/10 S M T W T F S	Wk. End. 11/17 S M T W T F S
Smith	Job. No. 1	x x 1 1 1 1 1	1 x x 2 2 2 2	2 2 x x 3 3 3	3 3 3 x x 1 1	1 1 1 1 x x 2	2 2 2 2 2 x x	x 3 3 3 3 3 x
Brown		1 1 x x 2 2 2	2 2 2 x x 3 3	3 3 3 3 x x 1	1 1 1 1 1 x x	x 2 2 2 2 2 x	x x 3 3 3 3 3	3 x x 1 1 1 1
Robinson		2 2 2 2 x x 3	3 3 3 3 x x	x 1 1 1 1 1 x	x x 2 2 2 2 2	2 x x 3 3 3 3	3 3 x x 1 1 1	1 1 1 x x 2 2
Jones		x 3 3 3 3 3 x	x x 1 1 1 1 1	1 x x 2 2 2 2	2 2 x x 3 3 3	3 3 3 x x 1 1	1 1 1 1 x x 2	2 2 2 2 2 x x
Breaker		3 x x 1 1 1 1	1 1 x x 2 2 2	2 2 2 x x 3 3	3 3 3 3 x x 1	1 1 1 1 1 x x	x 2 2 2 2 2 x	x x 3 3 3 3 3
Black	Job. No. 2	1 1 1 x x 2 2	2 2 2 2 x x 3	3 3 3 3 3 x x	x 1 1 1 1 1 x	x x 2 2 2 2 2	2 x x 3 3 3 3	3 3 x x 1 1 1
Green		2 2 2 2 2 x x	x 3 3 3 3 3 x	x x 1 1 1 1 1	1 x x 2 2 2 2	2 2 x x 3 3 3	3 3 3 x x 1 1	1 1 1 1 x x 2
White		x x 3 3 3 3 3	3 x x 1 1 1 1	1 1 x x 2 2 2	2 2 2 x x 3 3	3 3 3 3 x x 1	1 1 1 1 1 x x	x 2 2 2 2 2 x
Breaker		3 3 x x 1 1 1	1 1 1 x x 2 2	2 2 2 2 x x 3	3 3 3 3 3 x x	x 1 1 1 1 1 x	x x 2 2 2 2 2	2 x x 3 3 3 3
	Job. No. 3	1 1 1 1 x x 2	2 2 2 2 2 x x	x 3 3 3 3 3 x	x x 1 1 1 1 1	1 x x 2 2 2 2	2 2 x x 3 3 3	3 3 3 x x 1 1
		x 2 2 2 2 2 x	x x 3 3 3 3 3	3 x x 1 1 1 1	1 1 x x 2 2 2	2 2 2 x x 3 3	3 3 3 3 x x 1	1 1 1 1 1 x x
		2 x x 3 3 3 3	3 3 x x 1 1 1	1 1 1 x x 2 2	2 2 2 2 x x 3	3 3 3 3 3 x x	x 1 1 1 1 1 x	x x 2 2 2 2 2
Breaker		3 3 3 x x 1 1	1 1 1 1 x x 2	2 2 2 2 2 x x	x 3 3 3 3 3 x	x x 1 1 1 1 1	1 x x 2 2 2 2	2 2 x x 3 3 3
	Job. No. 4	1 1 1 1 1 x x	x 2 2 2 2 2 x	x x 3 3 3 3 3	3 x x 1 1 1 1	1 1 x x 2 2 2	2 2 2 x x 3 3	3 3 3 3 x x 1
		x x 2 2 2 2 2	2 x x 3 3 3 3	3 3 x x 1 1 1	1 1 1 x x 2 2	2 2 2 2 x x 3	3 3 3 3 3 x x	x 1 1 1 1 1 x
		2 2 x x 3 3 3	3 3 3 x x 1 1	1 1 1 1 x x 2	2 2 2 2 2 x x	x 3 3 3 3 3 x	x x 1 1 1 1 1	1 x x 2 2 2 2
Breaker		3 3 3 3 x x 1	1 1 1 1 1 x x	x 2 2 2 2 2 x	x x 3 3 3 3 3	3 x x 1 1 1 1	1 1 x x 2 2 2	2 2 2 x x 3 3
	Job. No. 5	x 1 1 1 1 1 x	x x 2 2 2 2 2	2 x x 3 3 3 3	3 3 x x 1 1 1	1 1 1 x x 2 2	2 2 2 2 x x 3	3 3 3 3 3 x x
		1 x x 2 2 2 2	2 2 x x 3 3 3	3 3 3 x x 1 1	1 1 1 1 x x 2	2 2 2 2 2 x x	x 3 3 3 3 3 x	x x 1 1 1 1 1
		2 2 2 x x 3 3	3 3 3 3 x x 1	1 1 1 1 1 x x	x 2 2 2 2 2 x	x x 3 3 3 3 3	3 x x 1 1 1 1	1 1 x x 2 2 2
		3 3 3 3 3 x x	x 1 1 1 1 1 x	x x 2 2 2 2 2	2 x x 3 3 3 3	3 3 x x 1 1 1	1 1 1 x x 2 2	2 2 2 2 x x 3

Legend: x—day off
●—dots over and under the Shift Breaker's "days on" indicate the upper or lower job he is to cover.
1—1st Shift—12 p.m. to 8 a.m.
2—2nd " — 8 a.m. " 4 p.m.
3—3rd " — 4 p.m. " 12 p.m.

How Much Money for How Much Work?

H. Resseger

Mechanical Division, The B. F. Goodrich Company
Akron

IN THESE days of NRA and manufacturing codes, the problem of determining fair rates of pay for piecework operation has been brought more forcibly than ever to the attention of plant executives. As a rule they have been satisfied to pay what they believed to be the going wage. The main weakness of a plan of this nature has been, of course, the difficulty in deciding to which class each job belongs. To overcome this it is imperative that there should be instituted some means of analyzing and rating the requirements in each job.

The setting of basic rates in the Mechanical Division of our company has always been given careful consideration by the management. In the past, however, this was done without any scientific means of analyzing the factors usually considered. The going wage in this locality and comparison with the base rates paid on various other operations were the only tools available for determining what amount would be a fair wage for a given amount of work. This was very difficult because of the innumerable operations necessary in producing 32,000 different rubber products.

It was realized that perhaps proper consideration had not been given all the factors in every job, or that a better knowledge of some operations may have thrown these rates out of relation to one another. To remedy any possible condition of this nature, it was decided to work out a definite plan of weighing the various factors and developing a sound basis for translating a given amount of work into hourly wages.

After making a survey of the methods generally used in such plans, a point system of *zoning* or *rating* was drawn up which eliminated at least part of the guesswork. The plan consists of analyzing certain factors in an operation and rating each with a varying number of points. Total points for any job equal 100. Operations are next classified as being in Zone A, B, C, etc., according to the total number of points allowed. A base rate is then applied to each zone. The factors used in this rating scheme are given in Table I.

	Maximum Points
1. Supervision exercised by operator	5
2. Judgment required by operator as to quality of product	10
3. Responsibility for material and quality	20
4. Responsibility for equipment	5
5. Manual dexterity	15
6. Working conditions (dust, heat, etc.)	10
7. Hazards	5
8. Physical requirements	5
9. Educational requirements	5
10. Learning period	20

Table I. Goodrich uses these factors to rate jobs

Labor supply and living costs were not analyzed and weighed in this plan as they are the governing factors in the basic wage or starting point. When carefully considered, the factors listed will compensate for higher skill or unsatisfactory working conditions found on operations rated above common labor.

The first step in applying this plan is to make a written analysis (Table II) of each operation. This is done by a time-study engineer. His analysis is then approved by the general foreman in charge of the production department.

Next the length of the learning period is determined. As this is one of the most important of the ten factors used, it is considered very thoroughly by a separate committee working with the factory supervision.

After all analyses have been made and learning periods agreed upon, the rating or weight of all factors in every

● *Goodrich evaluates jobs by scientific approach, adopts point system of classification, arrives at eminently fairer base rates*

1. *Job Description.* Write a brief but accurate general description of the kind of work embraced in this position.

2. *Supervision Received.* State name of position to which this one directly reports. Describe nature of supervision received, as immediate, general, continually checked, follows detailed directions, follows general instructions but executes them upon own responsibility.

3. *Supervision Exercised.* State briefly what occupations and how many are in any way directed or supervised by this one, and describe nature of supervision exercised. State what initiative and judgment are required.

4. *Responsibility for Materials and Equipment.* State briefly the responsibility of this position in regard to the value of the materials and equipment handled or used.

5. *Manual of Dexterity Required.* Give a description of any skill above ordinary required in this position.

6. *Physical Requirements.* State briefly what physical requirements are necessary for an operator in this position.

7. *Hazards or Unpleasant Working Conditions.* Explain briefly the hazards and unpleasant conditions encountered on this operation.

8. *Educational Requirements.* State briefly the necessary educational requirements.

9. *Experience and Previous Training Required.* Explain briefly what experience and previous training are essential, also approximate length of learning period.

Table II. A time-study engineer analyzes each operation

job is determined. This is done by a committee consisting of the general superintendent, staff superintendent, production superintendent, management wage representative, time-study manager, and the engineer who made the original analysis. Each of these men rates the factors independently after reading the analysis and discussing the job as a whole. An average is then made of the points allowed each factor by the individual and a composite total number of points is set up for the job. Thus it becomes a simple matter to assign every job to its logical zone. (See Table III.)

Despite the fact that the rate per hour paid for work in any one zone for a given amount of effort will fluctuate from time to time depending on labor conditions or other influences, the operation will always remain in the same zone, unless responsibilities, hazards, or other factors are changed.

Already the plan has proved far superior to the old arbitrary method of setting base rates. Rating factors by a group of men reasonably familiar with the job tends to eliminate the effects of biased opinions held by individuals regarding the value of a particular piece of work. It must be remembered that during this rating process no thought is given to old base rates.

The amount of effort expended in doing the job, a factor allowed for in many plans, is not recognized in this plan because it is provided for in the work standards set by the Time-Study Department. These standards are in terms of units of work, based upon time involved, speed at which the operation is performed, and degree of physical energy expended.

With the foregoing classification of workers 85 per cent completed and the analyses of operations 50 per cent finished, no really accurate statement of the extent to which the application of the zoning plan will raise the wages of some and lower the wages of others can be made as yet. However, it is expected that with the tendency for wages to rise there will in no event be any instance of an actual pay decrease for a worker. Rather than this, there might be a more delayed start on the upward scale, with those who obtain a higher rating receiving pay increases more rapidly than the rest.

Three Distinct Steps

The present Goodrich system of evaluating work and translating it into wages consists of three distinct steps:

1. Operations are classified into zones. To insure a composite opinion on the rating of each factor included in the job, classifications are made by a group of officials.

2. Base rates are set for each zone. These rates are determined by the managment. An understanding of the actual operations which fall into each zone is unnecessary.

3. The amount of work involved in an operation is measured by time-study engineers. A unit basis is employed with no consideration being given to the amount of earnings which might be made possible.

These three steps are taken entirely independently of one another and are carried out by different groups. The plan leads, it is felt, to a fairer system of wage payment than we have had in the past. Although we realize that the program may not be perfect in every detail and that the factors being used may not be applicable under other operating circumstances, we do feel that its adoption has already paid dividends by creating a better understanding between employer and employee.

Table III

BASE RATE ZONING—COMPOSITE SHEET

Operations	Supervision Exercised	Judgment Required	Responsibility for Material, Quality	Responsibility for Equipment	Manual Dexterity	Working Conditions	Hazards	Physical Requirements	Education	Learning Period	Total Points	Zone
Building Belts..	5	10	18	3	8	3	3	3	2	20	75	C
Sand Blasting...	0	3	3	2	3	10	4	4	2	4	35	H
Slab Mill.....	0	6	6	4	6	5	4	4	2	12	49	F
Lining Tanks...	4	8	14	2	9	6	4	3	3	20	73	C
Roll Finishing..	0	8	11	3	8	5	3	3	2	16	59	E
Cure Fan Belts..	5	7	8	3	6	5	3	2	2	10	51	F

Easy to

Leonard Church
Regional Editor
Cleveland

Packing cement. The dust system was shut down to take this photograph

DUST can be, and frequently is, a distinct hazard to physical well-being as well as to property where manufacturing operations include those of grinding and crushing, the agitation of materials in conveyors and elevators, the dumping of such materials into hoppers, or from bins or hoppers into other receptacles, or onto conveyors. The human body is well equipped to repel or to filter the larger dust particles without injury; but it cannot deal so successfully with dust of such fineness that the particles tend to remain in suspension in the air for hours at a time. Silica dust is of this dangerous character.

Dust-creating operations require a variety of means for suppression depending on the circumstances under which the dust is generated; sometimes it may only be necessary to make relatively simple changes in existing machinery.

For example, intermittent or continuous dropping of materials for any considerable distance creates dust which is thrown into the surrounding atmosphere. It is easy to inclose an existing chute or to install a fully inclosed chute at an angle which will lessen the force of the flow. Better still, by bringing the outlet as close as possible to the receiving point, it should be possible to avoid dropping materials any great distance.

More often, however, the dust problem involves three major considerations—suppression of dust at sources, complete collection, and final disposal.

The cost of a suitable system for the suppression and collection of dust depends largely on the volume of air needed to catch the dust at its source. This air volume influences the size of hoods and inclosures, piping system, dust collector, exhaust fan, fan motor, power supply, and floor space to be occupied. It naturally follows that in order to keep the cost low—first cost as well as operating and maintenance costs—the dust to be suppressed must be caught before it gets any distance away from its source.

Sources of Dust

Dust sources may be of various kinds. A tumbling mill in a foundry is a revolving barrel, tightly closed except for an air inlet and an outlet to the dust collecting system. While tumbling creates a very considerable amount of dust, it is confined and prevented from escaping by an exhaust pipe leading to the dust collector. This pipe may be comparatively small because there is no other escape for the dust, provided of course the mill is maintained in a dust-tight condition.

Again, dust from revolving screens, used in many industries to separate materials of various sizes, is fairly easily suppressed if the screens are suitably housed. Here, however, more air is needed; the volume exhausted must be large enough to create air currents entering the housing at the feed and discharge openings strong enough to counteract the force created by the agitation within and thereby keep the dust from escaping.

Vibrating screens are made dustproof as easily as rotary screens, and dust is prevented from escaping by exhausting from the housings a volume of air in proportion to the size of the openings. Vibrating screens require frequent observation of the process and more or less frequent attention for changing screens. Although at the time a dust system was installed suitable housings may have been provided for such screens, it has been the experience that these housings are either not kept tight or have been partially removed and not replaced in order to facilitate observation and changing of screens.

Dust is frequently caused by the discharge of materials onto open belt conveyors either from bins or crushers, or from other belts. Because the volume of dust created has its effect upon size and cost of the system, every effort should be made to reduce the agitation of materials at these points. Again, this is accomplished by shortening chutes as well as by easing up on the inclination of chutes so as to reduce the force of the falling material.

A close observation of the action of materials falling onto a moving conveyor will reveal that air currents travel with the conveyor; therefore, although the dust is created

Get Rid of Dust

Largely a matter of control at source, then collection, finally disposal

where the material hits the conveyor, this same dust will travel along the surface for some distance, depending on the speed of the conveyor. A hood should cover the conveyor for the distance that the dust travels along the belt, and the dust should be moved from that point to the collector. The purpose of this is to be able to catch the dust with the least force of ventilating air, considering that the volume of air, which determines size and cost of a system, is in direct proportion to air intake area and air velocity.

Although the ventilation of grinding wheels has been made the subject of laws or regulations in a number of states, most of them prescribe certain pipe sizes and air velocities predicated on the size of the wheel when, as a matter of fact, the suppression of dust created by the grinding wheel is more a matter of calculation on the basis of size of hood opening multiplied by velocity of air required to prevent dust from escaping.

The matter of agitation within hoods is of particular importance in connection with grinding wheels because the speed of the wheel throws the dust off with considerable force and in a very definite direction. It is therefore logical to attach importance to (1) peripheral speed of wheel, (2) direction of rotation, (3) point of contact between wheel and object being ground, (4) size of opening in hood necessary to permit grinding, (5) dimensions of the hood itself with reference to dimensions of wheel. Size of dust pipe and velocity of air in such a pipe are of little consequence unless these other factors are given proper consideration. Unreasonably high air velocities and air volumes, which increase first cost and power consumption, are not required if a hood of proper construction and design is used.

Inclosing the Source

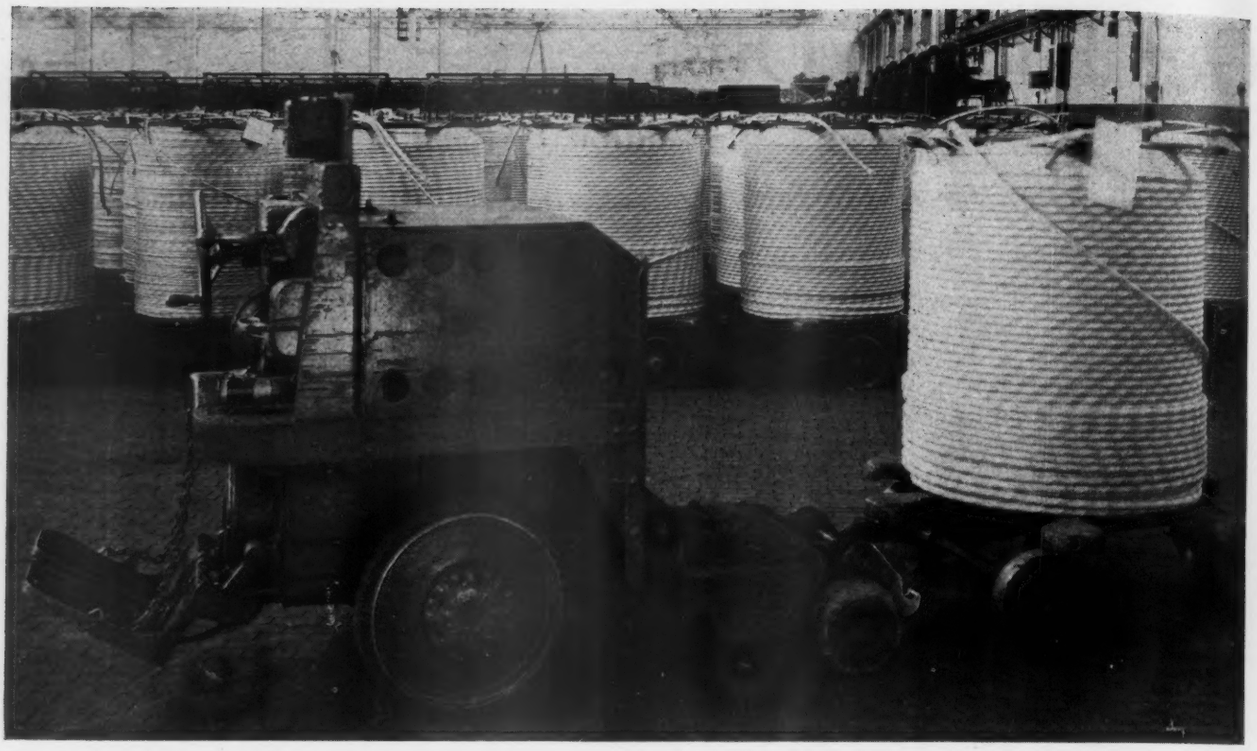
Dust escapes either because dust sources are not inclosed, or through openings in inclosures—openings which are needed for proper operation of machinery as well as unnecessary openings. It is necessary, as has already been pointed out, that dust sources be suitably inclosed, that inclosures be as tight as possible, that openings be made as small as possible. For observation of operations within inclosures it is well to provide windows equipped if necessary with wipers that can be manipulated from the outside. Lights may also be installed in the interior of such housings.

Machines that create dust, if perfectly housed with no openings for inlet or outlet of materials, would need no dust exhaust. Such a condition, however, hardly ever exists in industrial plants. Inclosures or hoods must be exhausted in order to prevent the dust from escaping through the necessary openings. The volume of air is arrived at after carefully measuring all openings. If no violent agitation takes place inside such inclosures, a velocity of 200 feet per minute is usually more than sufficient to prevent the dust from escaping through the openings. That is, if the aggregate area of the openings is 2 square feet and the velocity of air entering these openings 200 feet per minute, a volume of 400 cubic feet of air per minute will be sufficient to exhaust the inclosure.

Solving the dust problem is simple in principle, but often becomes difficult in practice because a great deal of dust-creating equipment is designed and built without regard to the necessity for exhausting it, making the application of hoods and piping difficult, particularly where it is necessary to observe the performance of such equipment from time to time and where more or less frequent access to machines must be had.

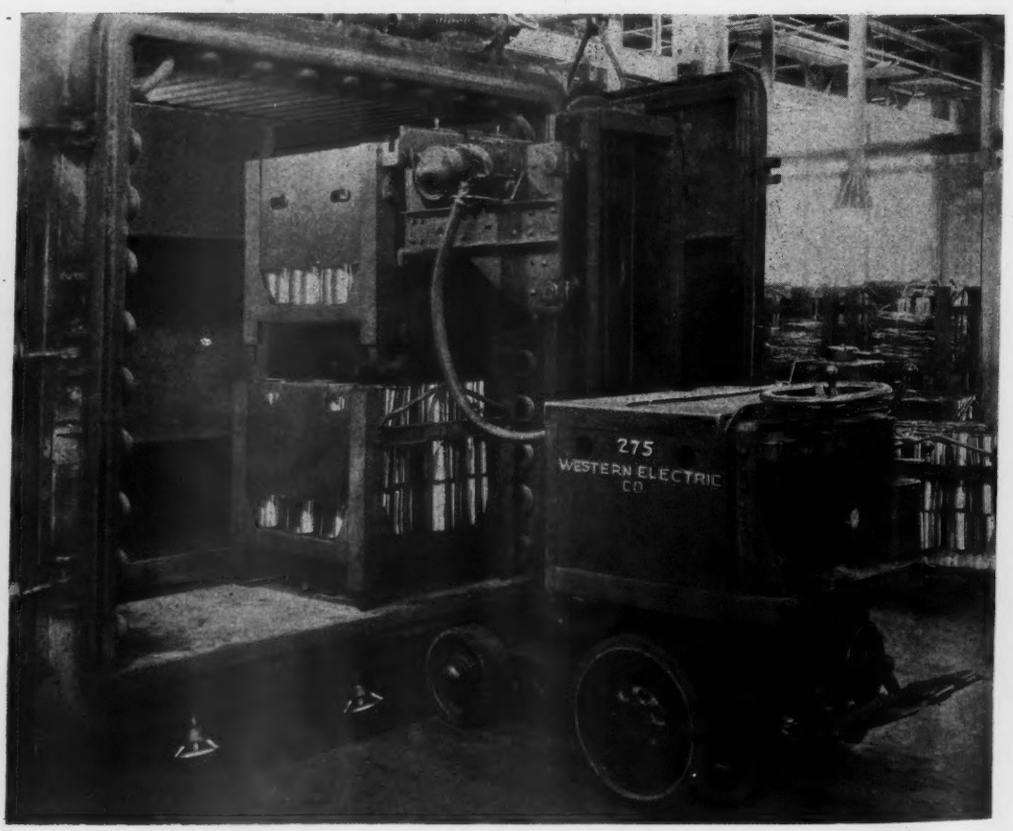
(*So much for control at source. A November article will cover collection and disposal.—Ed.*)

Same job, only the exhaust system was operating when this picture was taken



Moving heavy reels of cable core, often in restricted quarters, offered a nice problem which was solved by this gripper-type truck. The jaws shown at the back close and grip either the front axle or the rear caster of the cable truck, and lift it from the ground, thus distributing the weight over the two trucks

Precision Handling



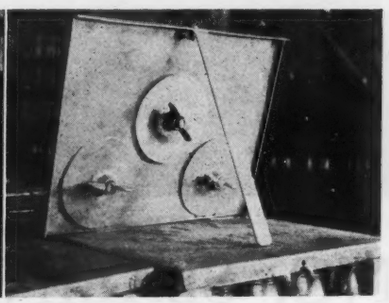
Tiering these wire skids in the close quarters of the annealing ovens requires very accurate control, as the tapered legs of the upper skid must fit into the corner uprights of the skid below. A lateral adjustment of 4 inches either way, in addition to the vertical lift, makes the operation feasible

Photographs by courtesy of the Western Electric Company, Hawthorne Works, Chicago

MANAGEMENT SHORTS

Perpetual Stock Indicator Tells How Many

K. THORNTON, Woodbridge, N. J.



A convenient inventory marker for grouped stock that moves rapidly can be very easily made from odds and ends. Size will depend upon the materials most readily obtained.

The marker shown was made at The Shell Terminal Corporation's Compounding Plant, Sewaren, N. J., from the cover of a discarded metal bottle crate 11 by 15 inches.

Blank wing nuts were welded on the back center of three 5-in. disks. The front of each disk was painted white, and numbers 0 to 9 were marked on it.

Three "windows" were cut in the cover so that one number on each of the disks shows through. The numbers are changed when stock is added or taken from the group. It is surprising how accurate this record has become.

Buffalo in winter. Breezes off the lake. The Arner Company, Inc., couldn't keep its plant warm—until it installed unit heaters, fifteen of them. They cost $3,500, saved $1,620 last winter in fuel alone. Better still, the plant was comfortable.

•

And in Philadelphia. Low-pressure boilers heat a paper box plant. Fires are banked at night. Building cools off. Printing room, however, must be heated 24 hours a day. Two electric unit heaters — one 25-kw. capacity, one 10—keep room warm at low cost.

•

Draftsmen at Patterson & Leich Company, Cleveland, specialists in welded steel constructions, walk on their drawings. This concern needed a drawing board big enough for full-scale layouts, lifted an idea from the shipbuilding business, laid a floor 50 by 80 feet on top of some bar stock racks, utilized waste space thereby.

In the interest of protecting electric heating units by insuring constant voltage at the terminals during light load periods, central stations selling power to factories are favoring the installation of regulators on feeders.

A Norwalk, Conn., hat concern checked motors to improve power factor. Many a piece of equipment for which the manufacturer had supplied the motor was over-motored, presumably as a factor of safety against possible abuse. Many a 5-hp. motor was replaced by a 3-hp. motor.

•

Washburn Wire Works, New York City, is trying out those new sodium lamps on inspection work. Although sodium light changes the appearance of colors—which doesn't bother the Washburn people—it has the definite advantage of showing up defects more clearly.

•

Another plant, slightly more than a stone's throw away from Washburn Wire, was getting poor inspection results on the night shift. Defects were getting by, don't any more. Improvement credited by factory manager to newly installed mercury vapor lamps.

•

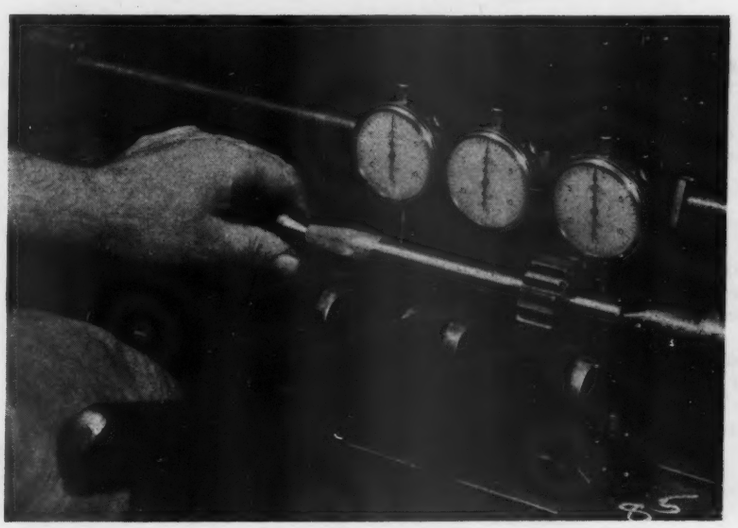
In a Massachusetts small-tool factory dry turnings and machined parts, after oil extraction, are passed through a separator which retains the parts and blows the turnings to a storage pile outside the building.

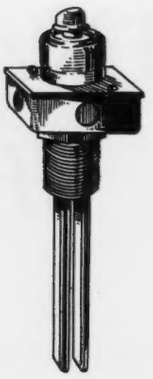
•

Really Straight—No Foolin'

SOURCE: Apex Electrical Manufacturing Company, Cleveland

Agitator shaft assemblies for washing machines must be really straight. What could be more likely to insure straight shafts than the 3-lever, 3-gage device pictured? Differs from the usual method of straightening in that it eliminates repeated moving of shaft between straightening fixture and gage.

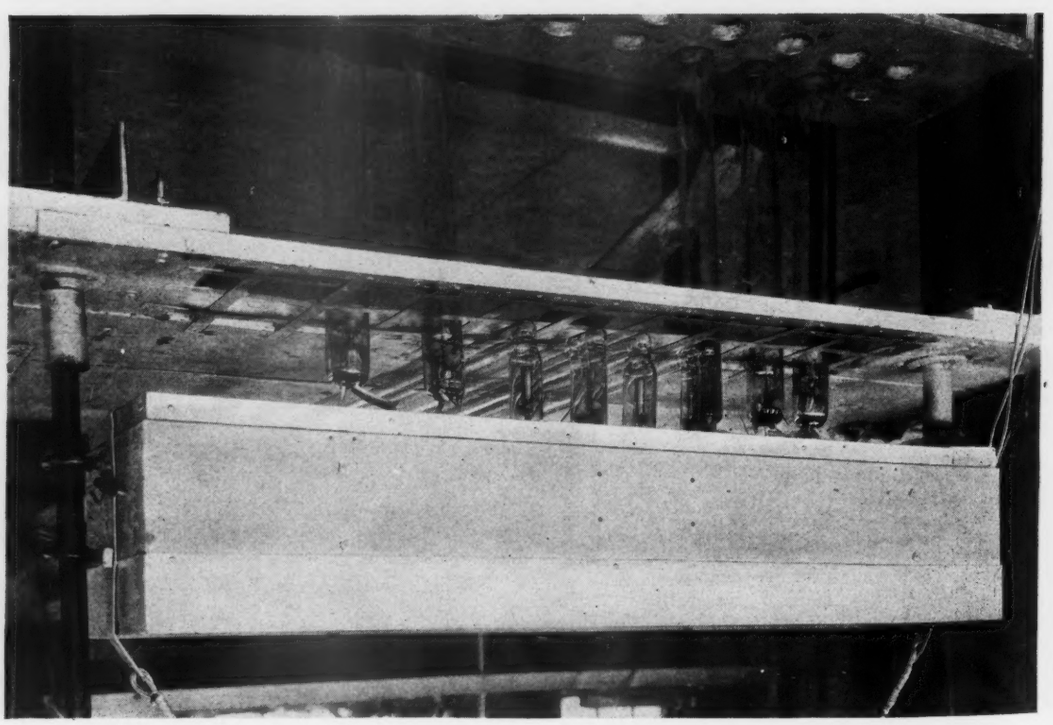




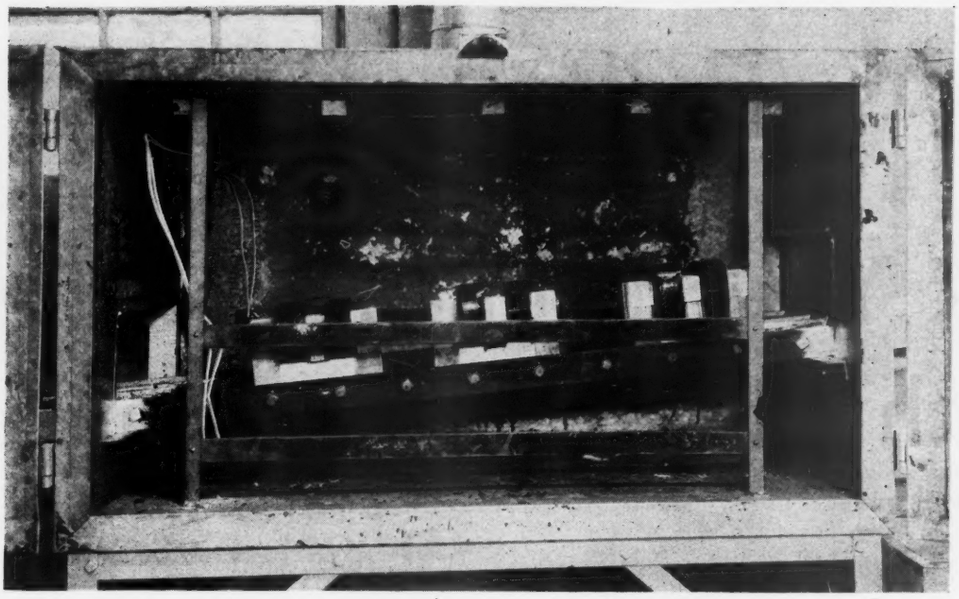
In pumping a vacuum of approximately 4/10,000,000 inch of mercury, impurities detrimental to tube operation such as carbon dioxide, must be vaporized. Heat for the vaporization is supplied by a 2½-kva., high-frequency induction furnace bombarder, drawing 60 amperes with a secondary voltage of 10,000

VAPORIZING, SEALING, DRYING,

FOUR important jobs are done by electric heat for Claude Neon Displays, of Buffalo, in the manufacture of neon tubes. Economy of operation and ease of control were the prevailing factors influencing selection. The captions tell the stories



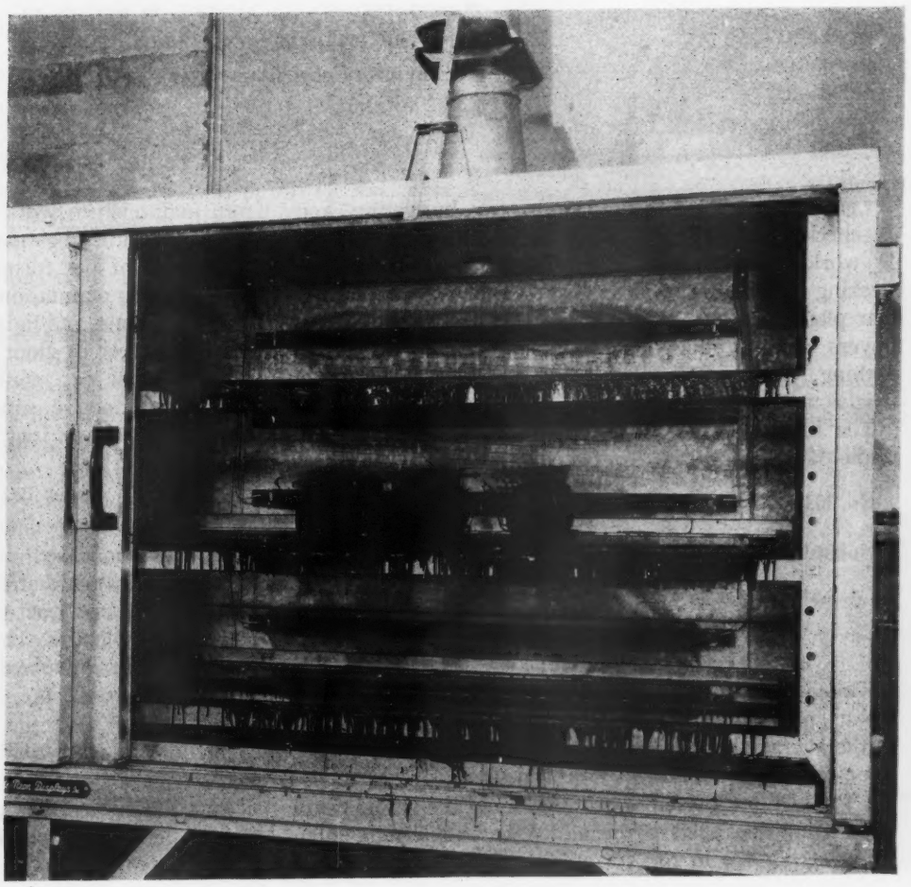
Sealing compound protects the wires where they emerge from the tube. A resistance heater rated at 0.6 kilowatts keeps the compound fluid after it has been poured, until impurities and air bubbles rise to the top. 200 degrees Fahrenheit is maintained for 20 minutes. Hand torch was used formerly



Transformer coils are dried before varnishing. The electric heater is rated at 3.2 kilowatts, is thermostatically controlled to hold 250 degrees Fahrenheit for 25 minutes. Coils pass through the furnace on gravity rolls

BAKING *by* Electric Heat

Baking transformers after varnishing. It's a 7½-kw. furnace, and 250 degrees Fahrenheit is maintained for 8 hours. Thermostatic control, also time clock that shuts off power at the end of the period. Exhaust ducts carry away the fumes



C. J. Stuart
Industrial Engineer, New Haven, Conn.

Check Your Maintenance Costs With This Simple Formula

$$m = \left(\frac{a}{684} + \frac{b}{889} + \frac{c}{605}\right) = d$$

Where a = square feet of floor space in active use
b = pounds of finished goods produced in month
c = replacement value in dollars of all machines and equipment in active plant account
d = average hourly pay rate, in dollars, of all maintenance workmen
m = monthly cost of maintenance labor, in dollars

I HAVE developed a formula for budgeting and checking maintenance expense. It is empirical, but it works; I have satisfied myself as to its soundness by checking it against the maintenance expenses of twenty-four plants. These plants have from 150 to 5,000 employees, make products as varied as chemicals, footwear, clothing, tires, mechanical rubber goods, small metal articles, and textiles.

The formula is given in the display. Here is an example of its use:

a = 308,000, b = 600,000, c = $408,000, and d = $0.54

Substituting in the formula,

$$m = \left(\frac{308{,}000}{684} + \frac{600{,}000}{889} + \frac{408{,}000}{603}\right)0.54$$
$$= \$971.77$$

This formula is based on data secured in six plants. In any plant, obviously, the total labor hours multiplied by the average hourly rate will give the total maintenance labor cost approximately.

I found three principal groupings for the labor, hence there are three parts to be added to obtain total labor hours, as shown in the formula. The data were taken from maintenance work orders that had been executed over a period of six months in the six plants.

Part one of the formula is based on the labor hours consumed in maintaining buildings, sprinkler systems, heating systems, and lighting systems, taking into account the square feet of floor space in active use. The total hours of labor per month on this class of work divided by the total active square feet of floor space equals "hours per square foot." The result from my data is

$$0.00146 +, \text{ or } \frac{1}{684}$$

Part two is based on the labor hours consumed in maintenance work that fluctuated nearly in proportion to the amount of product turned out. I secured a fraction representing "hours per pound of product," by dividing the total hours involved by the pounds of product finished. The result is

$$0.001124 +, \text{ or } \frac{1}{889}.$$

Part three furnishes the "hours per dollar of replacement value of equipment," and was found by dividing

(Continued on advertising page 64)

To Help You Select Insulated Wire and Cable

R. B. McKinley

Engineer, Wire and Cable Section
General Electric Company
Bridgeport, Conn.

WIRE and cables for electrical work are composed essentially of a conductor, insulation, and one of several types of finish, depending upon the usage, to protect the insulation. Selection of the proper type is of extreme importance in obtaining long life.

Copper is most widely used for the conductor, although special commercial applications may warrant the use of aluminum, monel, bronze, steel, or nickel. The conductor may be either solid or stranded, increased flexibility being gained with an increase in the number of individual wires composing the conductor. When rubber insulation is to be used the copper is given a very thin coating of metal, such as tin, or is covered by cotton, paper, or other material to prevent chemical action between the copper and the rubber compound, which causes rapid deterioration of the metal conductor. A tin coating is also desirable to facilitate soldering.

The insulation is usually composed of rubber compound, asbestos, cotton, paper, or varnished cloth; sometimes a combination of these materials may be used.

Finishes over the insulation may be one of the following, or some combination: Braids of cotton, jute, or asbestos, usually treated to prevent moisture absorption and, with asbestos, to prevent heat radiation; braids of art silk (rayon); lead sheaths; tough rubber jackets; metal armor; or felted coverings of cotton or asbestos.

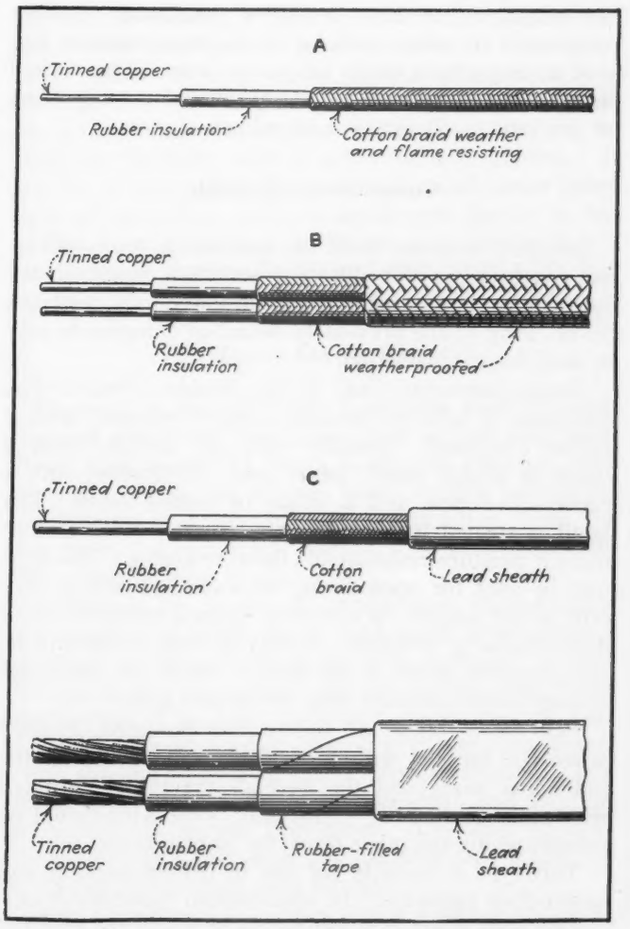
Grades of Rubber Insulation

During the past few years intensive research and development have been carried on with the object of designing better rubber insulations for cable use. These studies have resulted in the use of anti-oxidants and organic accelerators that greatly increase the life of the insulation. Most common rubber compounds are:

National Electrical Code—This compound contains at least 20 per cent of rubber and is designed to meet all requirements set forth by the National Board of Fire Underwriters.

Intermediate—Contains at least 25 per cent new rubber. It is an insulation of intermediate quality designed for use where material better than N. E. Code, and less expensive than 30 per cent, is wanted.

Thirty Per Cent Grades—The two most common 30 per cent compounds are those made in accordance with A.S.T.M. Class A or Class AO specifications. The Class A compound contains 30-33 per cent new rubber. The remaining ingredients are of materials specified by the American Society for Testing Materials. The Class AO compound also contains 30-33 per cent new rubber, but the manufacturer is allowed more latitude with the remaining constituents. Electrical requirements of the two compounds are identical, but the Class AO material must meet more stringent physical requirements and must be capable of passing accelerated aging tests. These aging tests are made by placing samples of the compound in an oven at a temperature of 70 degrees C. at atmo-



***A*—Single-conductor code wire, braided finish. *B*—Flat-twin code wire, braided finish. *C*—Single- and two-conductor, rubber-insulated, lead covered cable**

spheric pressure, or in a "bomb" containing oxygen at a temperature of 70 degrees C. under a pressure of 300 lb. per sq. in. After 96 hours under such conditions the depreciation in tensile strength or elongation must not be more than 15 per cent for the oven-tested samples, nor more than 25 per cent for the oxygen bomb samples. (Each 24 hours' aging in the bomb is estimated theoretically to be approximately equivalent to 2.5 years of actual service under average conditions).

For Critical Circuits

Performite—This insulation contains various percentages of new rubber, as required, compounded with anti-oxidants and organic accelerators so that its tensile strength or elongation shall not depreciate more than 20 per cent after 336 hours in the oxygen bomb nor more than 30 per cent after 504 hours under the same conditions. Recommended for extremely important circuits where unusually long life and satisfactory operation are absolutely essential.

In order to facilitate identification and checking of the life, many purchasers require that the compounds have distinguishing colors, such as black for N.E. Code grade, red for Intermediate grade, and green for 30 Per Cent grade.

For special applications rubber compounds are available having low-moisture absorption, corona resistance, heat-resistance, or high insulation resistance. Rubber compounds are often used for tough, wear-resistant jackets, as on portable cables subject to severe abrasion and sharp blows. These jacket stocks should contain from 40 per cent to 60 per cent of rubber.

Constructions Available

Insulated wire and cable are available in many different constructions for different services. Some of the most common types using rubber insulation are described below. Any of the previously described compounds may be used for the insulation.

Single-Conductor Code Wire, Braided Finish—The conductor is solid or stranded copper insulated with a rubber compound. Smaller sizes are finished with a single or double braid; larger sizes are finished with a rubber-filled tape and a single or double braid. The braid is treated to give the cable a slick finish and to make it moisture-resisting and flame-retarding. This type may be used for open wiring on walls and ceilings, except where subject to corrosive vapors, or when rapid deterioration is probable. It may be used in conduit or for concealed work in the hollow spaces of walls and ceilings when mounted with knobs and tubes.

Flat-Twin—Made of two rubber-insulated, braided wires laid parallel with a braid over-all. Braid on the individual wires and the over-all braid are saturated with moisture-resisting compound. One wire should be colored white, the other black for identification.

This type is suitable for use in unlined conduit and under-floor raceways. In open-bottom raceways it cannot be used where it is impossible to install the required pad for crossing conduit or structural steel. (In such cases, use armored or non-metallic sheathed cable.)

Non-Metallic Sheathed—Each of the rubber-insulated wires (solid or stranded conductor) is covered with a braid of mixed paper and cotton, a paper wrap, and the conductors laid up with jute fillers. Over the assembled singles is a paper wrap and an over-all cotton braid saturated with a flame- and weather-resisting finish. An uninsulated copper conductor for grounding may be laid next to the insulated conductors.

Cable of this type may be mounted directly on woodwork, plaster, brick, or other building finish. It may also be installed in conduit or in surface or under-floor raceways. When exposed to mechanical injury, it must be protected by rigid conduit or other approved means.

Armored Cable, Non-Leaded—The individual conductors are rubber-insulated, covered by cotton braid with a flame-retarding and moisture-resisting finish. The singles are then twisted together and covered with a wrapping of fibrous material, over which is applied a flexible armor composed of galvanized-steel strips wound helically. Adjacent turns of the steel strips are interlocked.

This cable is suitable for voltages up to 600 volts. It may be used for open or concealed work in dry locations, and may be fished. When run on brick walls or similar masonry it may be embedded in the plaster unless there is excessive humidity.

Lead-Sheath Cables

Armored Cable, Leaded—Construction is similar to the preceding type, except that a cotton braid or rubber-filled tape and lead sheath are applied over the assembled conductors, underneath the armor. (In two-conductor, flat, the braid or tape is omitted under the lead.) This cable is recommended for underground runs and on other circuits embedded in masonry, concrete, or fill in buildings in course of construction, and elsewhere if the location is such that the cable will be exposed to weather, continuous moisture, excessive humidity, or if subjected to oil, gasoline, or other materials having a deteriorating effect on rubber insulation.

Rubber-Insulated, Lead Covered—Furnished with solid or stranded conductor in single- or multiple-conductor cable. In all cases there must be a fibrous covering directly over each rubber-insulated conductor. In single-conductor cable the lead sheath is applied over this fibrous covering. In two-conductor, flat cable the singles are laid parallel and the lead sheath applied. When more than two-conductor cable is wanted the singles are stranded together helically and a fibrous covering, such as tape or braid, is applied over this core before leading.

Leaded cable is recommended in many cases where the environment is such that rapid deterioration of unprotected conductors or insulation is probable. It is sometimes more economical to install leaded cable than the braided type, because of its longer life, where it is difficult and expensive to install the cable. The lead-sheathed type is often desirable also on high-voltage power circuits on which corona would be formed.

If a lead-sheathed cable will be subjected to vibration care must be exercised in its selection. Excessive vibration causes failure of commercially pure lead sheaths. Use of a sheath containing a small percentage of tin or antimony decreases the probability of failure.

Here's a Cure for Floors Like This

E. Perry
Oakland, Calif.

CONCRETE surfaces under wear produce a fine powder and without special treatment do not wear as long as they should. This condition may be serious—as for instance where dust settles on objects to be varnished or lacquered, or in machinery bearings.

For a number of years there have been on the market materials for the purpose of hardening cement particularly at the surface to prevent disintegration from wear.

Magnesium fluosilicate, as such or under trade names, is in water solution a colorless chemical which, when applied to concrete floors, permanently transforms the cement into an insoluble granite-like substance. By its use a soft floor can generally be made dustproof and wearproof without altering its original color and appearance. Application may be by any means, the intention being to saturate the concrete as deeply as possible and then allow it to dry out thoroughly before painting or repeating the hardening treatment. This material is also referred to as magnesium silico-fluoride crystals, approximate chemical formula $MgSiF_6.5H_2O$, and is readily obtainable from chemical supply houses at nominal cost.

Hardens, Wearproofs, Dustproofs

Hardener of this type cannot be used on a concrete floor which has previously been painted or waxed, but a floor treated with this hardener may subsequently be finished with an oil paint or floor enamel. In fact, the magnesium fluosilicate reduces the natural alkalinity of cement that sometimes disintegrates paint.

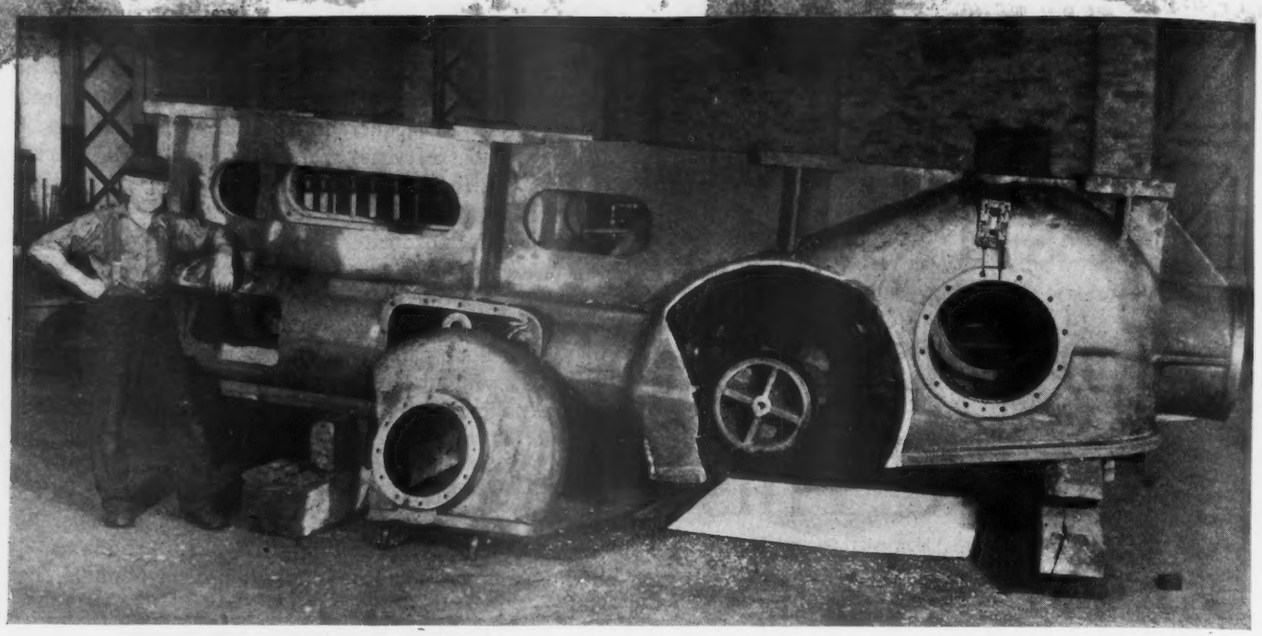
The action of magnesium fluosilicate is primarily a chemical one. It hardens, wearproofs, dustproofs, reduces the porosity of cement and concrete surfaces by filling in the pores with a newly formed mineral. It provides a close-grained floor surface, which under heavy wear will take on a polished appearance similar to that of flint. On account of its dense inert nature such a floor becomes immune to oils and most weak acids, and can be readily cleaned with water.

How to Do the Job

Floors to be hardened with fluosilicate must be clean, dry, and absolutely free from oil or grease and paint. Three applications, 24 hours apart, are essential, with overnight drying out of the latest coating before the floor is used. To get maximum penetration, flush the floor with the liquid and spread it around uniformly with a long-handled brush.

Dissolving 2½ pounds of magnesium silico-fluoride into 1 gallon of either hot or cold water gives about 1 gallon of 15 per cent stock solution, sufficient to treat 100 square feet of average concrete surface with three applications. The first application should be one part of the 15 per cent solution diluted with two parts water, a thin solution to give an initial deep penetration. The second application should be half-and-half base solution and water, for normal penetration. The third application may be one part base and one-half part water, or the 15 per cent solution used straight.

Such a treatment of factory floors is simple and does not interfere with the operation of the plant. If the work is done at night, the floor may be used the next morning as usual.



Welding

SAVED THIS 10-TON CASTING

During manufacture a section of a ten-ton pump casting was broken out. By bronze welding with oxyacetylene the manufacturer was able to repair the damage for about six per cent of the replacement value and deliver the casting on time. There was about 12 feet of welding in material 1 inch thick

Hard Surfacing

MADE THIS VALVE SEAT LONGER LIVED

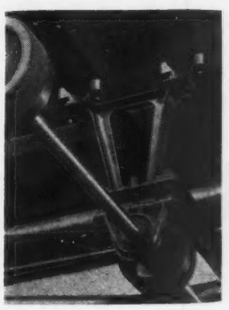
This 9-in. valve disk for high-temperature, high-pressure steam service is being hard-faced with a non-galling, non-ferrous alloy of cobalt, chromium, and tungsten which is especially resistant to abrasion, corrosion, and erosion and retains its inherent hardness at a red heat. After preheating to 1,100 deg. F., the disk is faced with a ¼-in. layer of hard-facing alloy as shown and is then reheated to 1,250 deg. F., and furnace-cooled. Gate and globe valve seats and disks faced in this manner outlast usual materials six to ten times

When You Get Your Bearings

Francis A. Westbrook
Consulting Engineer, Center Conway, N. H.

IN A CERTAIN plant a saving of 15 per cent in power consumption and 97 per cent in lubricant was realized by replacing old-fashioned shafting hangers with new ones equipped with ball bearings. There were additional savings due to reduction on cost of attendance, avoidance of shutdowns, decreased wear and tear on belts transmitting 15 per cent less power, greater cleanliness, and the general advantages due to the smoother running machinery. This step in the direction of modernization evidently paid handsome dividends and is one that can be readily taken in many industrial plants.

It must be borne in mind that identical bearing problems are practically never found in any two industrial plants, and that in the rapid changes which all industry is undergoing these days bearing requirements are anything but static. Consequently research and development work are essential with respect to design, choice of raw materials, and manufacturing processes. Bearing manufacturers who carry on such activities make the results available to their customers, and it would seem no more than ordinarily intelligent to use them.



THESE plants found anti-friction bearings offered savings in power, lubrication, and maintenance that more than offset increased first cost. Here is one step toward modernization that can be profitably undertaken in many plants

To show the importance of using bearings having as little friction as possible and of selecting the proper design for each given set of conditions, a few actual applications, with their results in widely different fields, will be briefly outlined.

Anti-Friction Bearings Paid Out in Two Months

A typical example is the experience of the Olson-Serley Sash and Door Company of Minneapolis which substituted ball-bearing pillow blocks for babbitted bearings on a duplex fan. This fan is used to collect dust and shavings and to deposit them in the boiler room. The babbitted bearings required a great deal of attention and a 48-in. pulley and 36-hp. engine were required to drive the fan. With ball bearings the power consumption was reduced 14 per cent, the labor cost 94 per cent, the lubricant 87 per cent. The ball bearings paid an annual return on the investment, including depreciation, interest, maintenance, and repairs, of some 660 per cent. That is to say, they paid for themselves in less than two months.

A very interesting basis of comparison between babbitted and ball bearings is afforded by the experience of the Cleveland Stone Company which saws flags from rough blocks of sandstone at its three mills near Amherst, Ohio. Two of these mills are modern and are equipped with shafting supported by means of ball-bearing pillow blocks of types suitable for the service. There are in all 82 such bearings. The third mill is an old one; the bearings are babbitted.

On the basis of its experience with the old type of bearings the company's engineers have calculated that it would cost $2,000 a year for attendance, $88 for oil to care for the 82 bearings in the two new mills if they were of the babbitted type, whereas the actual operating cost is only about $785 a year. Thus the saving amounts to some $1,300 a year, which pays out the first cost of the ball bearings in four years. But this does not take account of the reduction of accident hazards due to frequent oiling of babbitted bearings while the machinery is in motion, the elimination of the expense of re-babbitting every once in a while, and the loss of production from corresponding shutdowns. The ball bearings need lubrication once in three or four months, and fatigue failures occur only after years of service.

A coal mining company, the Keystone Coal and Coke Company of Greensburg, Pa., changed the motor bearings of twelve of its mine locomotives from sleeve to ball bearings. It had been found by past experience that the locomotives were usually tied up about twice a year by bearing trouble. The repair bill alone usually amounted to $130. Loss in production time, assuming a 2-hour tie-up and 100 loaders idle for that length of time, amounted to about $165. In other words, a bearing failure might easily cost $300 and often did.

Furthermore, the amount of lubricant used and the labor of applying it was found to be a great deal more with sleeve than with ball bearings. By keeping careful records and analyzing them it has been shown that the annual savings are about 57 per cent and that the cost of making the change-over will be paid three times during the average 5-year life of the bearings—an extremely conservative estimate, incidentally.

A further interesting point in this change-over is the fact that single-row ball bearings were first tried and showed very little improvement over sleeve bearings. It was not until double-row ball bearings were used that the advantages enumerated above were realized—a striking example of the necessity of using bearings of proper design for the service conditions to be met.

MAINTENANCE SHORTS

An Automatic Kickoff For Hot Steel Bars

GILBERT LINDGREN, Asst. Chief Electrician
Hudson Valley Fuel Corporation
Troy, N. Y.

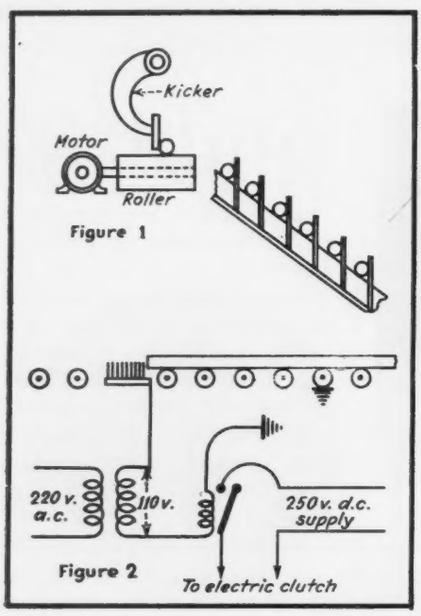


Figure 1

Figure 2

In the rod mill of a large steel plant the finished white hot bar of steel leaves the finishing rolls at a very high rate of speed, traveling along a row of motor driven rollers and must then be kicked off these rollers onto a stationary cooling bed or rack as shown in Figure 1.

This kickoff was at first operated by means of a lever connected to a mechanical clutch, the operator standing in a pulpit overlooking the cooling bed. The trouble with hand operation was that the operator at times did not watch his work and allowed the bar to overtravel, damaging it and delaying operation, or he would kick the bar off too soon and cause the next bar to jam. Finally the mill superintendent called in the chief electrician and told him to operate the kickoff with "juice."

The first thing we tried was a switch mounted directly above the bar and operated by a paddle struck by the passing bar.

The switch was to close a circuit to an electric solenoid which would operate the clutch. The first bar struck the paddle and away went paddle and all. We had greatly underestimated the force of the bar.

So a much stronger switch was tried. Now the switch held but the smaller bars buckled at the end when they struck the paddle.

At last a light began to shine when one of the electricians suggested that we allow the bar to pass through a wire brush and make contact with the bristles. The wood back of an ordinary wire brush was replaced by a copper plate and the brush mounted on an insulated bracket. As all circuits are kept free of grounds we used a transformer and connected it as shown in Figure 2. The 110-volt circuit operating a contactor which closes the 250-volt d.c. circuit to the clutch.

Mr. Lindgren's contribution has been awarded the $10 payment offered by the editors for the best Maintenance Short submitted during the past month.

•

Melting Pot Revamped for Electric Heat

Central steam source to supply heat for steam-jacketed pots in which flammable materials are melted has always been considered a necessary part of the equipment of paint and varnish plants. But it is expensive.

The superintendent of one such plant built an electric melting pot, consisting of a sheet-metal cylindrical shell 40 inches high and 33 inches in diameter, with a lining of insulating brick inside. The heating unit consists of standard stock strip heaters mounted between two steel hoops fastened inside the container. The melting pot is lowered inside the heater assembly.

Revolving paddles operate inside the wax pot, thoroughly mixing the contents. The revamped pot, with a capacity of 30 gallons, will turn out 1,000 lb. of melted products per day.

Accurate heat control, necessary when some materials are to be added at definitely predetermined heats, is obtained by means of a dual control system, consisting of a first range which carries up to 120 deg. F. and a second which goes on to 450 deg. F.

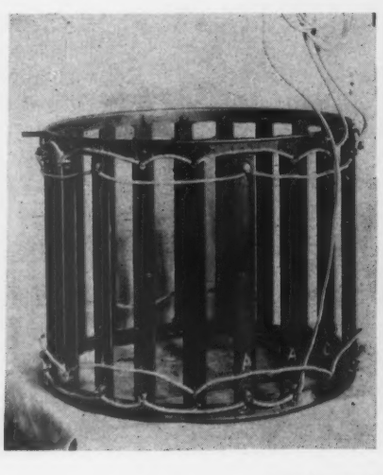
•

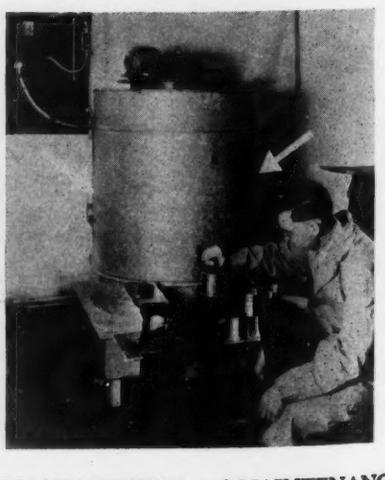
Carrying Cylinders Four at a Time

SOURCE, Air Reduction Sales Company
New York

In a Maine iron works the transportation of heavy oxygen and acetylene cylinders from place to place about the plant was quite bothersome. The superintendent decided to use the crane and built a carrier for the purpose. It holds four cylinders at a time and was fabricated by welding.

The carrier frame is made of ½-in. standard galvanized pipe welded to a ⅜-in. galvanized steel base plate. The retaining bands are made to accommodate two oxygen and two acetylene cylinders. They turn on pipe hinges, and are locked in position by slots two inches long, engaging on pieces of flat bar section welded to the carrier frame. They are held in the locked position by safety catches of flat spring steel with handles, as shown in the photograph. Release is effected by pulling out the





safety catch and lifting the bands two inches to clear the locking device.

The top hook is made of forged steel, and is fitted with a device designed to prevent the hoisting chain unshipping if any obstacle is encountered in the lowering of the carrier.

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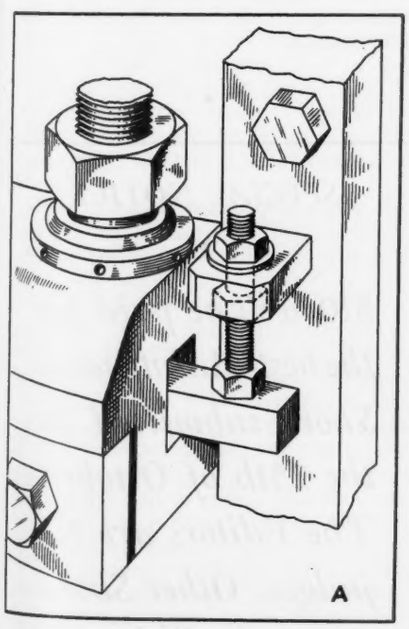
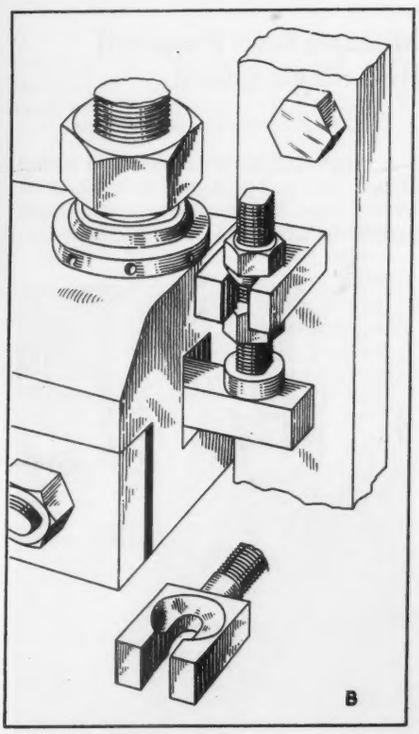
Knockout Bolt Reduces Press Set-up Time

CHAS. H. WILLEY, Penacook, N. H.



A battery of large stamping presses required a number of set-ups a day, which necessitated frequent changes in the knockout bars for the different dies. Oftentimes the set-up bar was poorly adjusted, with the result that the threads were damaged and the nuts hard to turn. The fact that three wrenches were required for the old type of stripper bolt, as shown in diagram *A*, was a further disadvantage.

In order to eliminate these troubles a knockout bolt, diagram *B*, was designed. It requires only one wrench for adjustment and can be quickly removed when it is not needed.



The holder for the screw is slotted and cone-cupped; the nuts are taper-faced, and bolts or screws are milled flat on two sides.

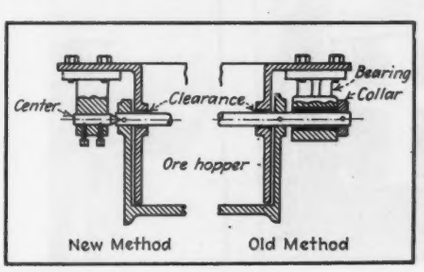
•

Hardened Centers Replace Bearings

E. MILTON SEIFERT, Brooklyn Park, Md.

A large acid-manufacturing concern has a constant-flow pyrites ore feeder. The feeder operates with a rotary calcining furnace. The furnace develops about 1,800 deg. F. On the feeder are high-temperature-resisting sleeve bearings, and these caused trouble by sticking. Their average life was about two weeks, and when they failed the entire feeder had to be removed and replaced. That cost money.

So the Engineering Department took out the bearings and replaced each with a hardened center. These centers last about 6 months.



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68 Per Cent Dividends From Power Factor Correction

SOURCE, The Richman Brothers Company
Cleveland

In the eight months since we installed a 90-kva. bank of capacitors, our power bills have been reduced by a total of $439, half the cost of the installation.

Service is supplied to our plant, which manufactures clothing, at 4,600 volts and is stepped down to 230 volts. Average demand varied from 180 to 350 kw. and the average power factor was 72 per cent. The capacitors raised this to 90.7 per cent and realized month-by-month savings as follows: November, $48; December, $64; January, $73; February, $61; March, $55; April, $57; May, $41; June, $40. The 8-month saving of $439 is at the rate of 68 per cent of the previous power cost.

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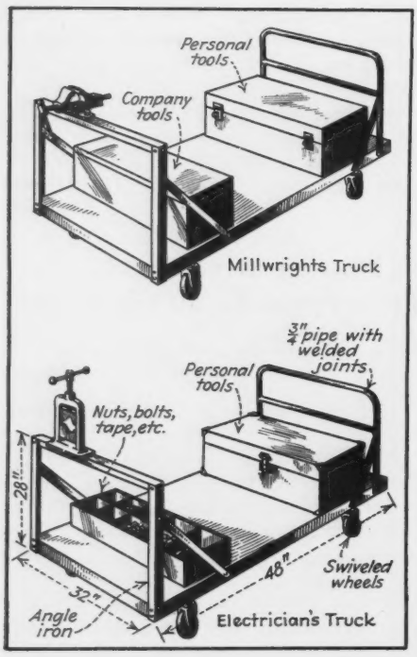
Small Trucks Save Maintenance Men's Time

CHAS. A. PETERSON, Electrical Department
Bendix Products Corporation
South Bend, Ind.

In one large plant all maintenance and construction men are provided with a light truck on which all material required for any job can be brought at one trip. One of the sketches shows an electrician's truck, which can be loaded with everything needed for an ordinary



job of moving or replacing a motor, so that it is not necessary to make extra trips to the storeroom.

Pipe fitters and millwrights are provided with similar trucks. Several men and their trucks may be assigned to large jobs.

Painters use a somewhat different type of truck, suitable for carrying ladders, planks, and so on.

Since the adoption of this plan much time that was formerly wasted in going to and from the storerooms is now utilized in productive work.

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Electric Eye Saves Time in Shop

J. M. Heggy, Meter and Instrument Division, Westinghouse Electric and Manufacturing Company, Newark, N. J.

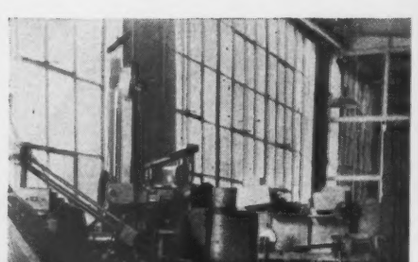
The advantages of keeping closed the double doors between two departments of our plant were negatived by the delays and difficulties encountered by workmen who had to pass with arms full or with loaded trucks. The installation of electric door openers controlled by electric eyes on either side of the doors eliminated the delays. Now when a workman with loaded truck approaches the door he intercepts a light beam and the door automatically opens for him, closes behind him.

•

Multiple Belts Protected By a Single Guard

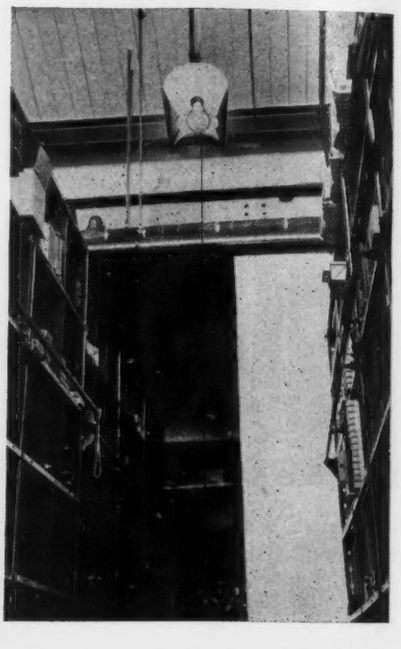
H. S. Knowlton, Boston, Mass.

A single belt guard covering a group of belt and pulley drives in connection with a speed-changing set-up at a brush handle machine in a New England factory frees the aisle from danger without encroaching on valuable space and leaves the adjusting wheel in front of the motor clear for the operator's use.



Reflectors Light Narrow Aisles in Storeroom

Source: Norma-Hoffmann Bearings Corp. Stamford, Conn.



Close spacing of metal bins in the small parts storeroom made good lighting difficult. In order to concentrate light downward and along the extent of the aisles, special reflectors were installed. Half-cylinder-shaped tops reflect the light the long way of the aisles and flaps on the sides draw together somewhat at the center, flare out at the ends to give more even distribution of illumination.

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SPECIAL NOTICE

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$10 will be paid for the best Maintenance Short submitted by the 25th of October. The Editors are the judges. Other Shorts accepted will be paid for at attractive rates

QUESTIONS and ANSWERS

Conducted by G. A. VAN BRUNT

Measuring Temperature of Motor Coils

I wish someone would outline the best practical method of determining the temperature of motor and other coils at the hottest point. I understand that a thermometer attached to the outside of the coils will not give the true temperature of the interior of the coils. I should like to know whether there is any way of measuring it. If not, can it be estimated with reasonable accuracy?

M.D.—Baltimore, Md.

WITH new machines it is customary to watch the temperature carefully in order to determine the hottest points, or the "hot spot" temperatures, as they are usually called. There are three general methods for determining coil temperatures: (1) By the use of thermometers; (2) by measuring the change in resistance; (3) by the use of embedded temperature detectors.

When using the first method a correction of 15 deg. C. is added to the thermometer reading in order to obtain the hottest spot temperature. With the second method an addition of 10 deg. C. is made. The addition with the third method varies from 5 to 10 deg. C., depending on the type and voltage of the winding. Full details are given in the Standardization Rules of the A.I.E.E.

Although a thermometer is easy to use the results are uncertain, since it must always be applied to the outside of the coils.

The resistance method gives only the average temperature of the winding, without definite indication of the hot spot temperature.

The third method comes closest to giving the actual hot spot temperature, since the detectors are located at one or more places in the windings and give an indication of the variation in different parts of the machine. In the case of a motor stator the detectors are placed at the bottom of a slot, or between the top and bottom coils. Detectors can be made up in various shapes, to suit the space requirements.

Temperature corrections given above are based on actual experience, and since the maximum temperatures range from 105 to 125 deg. C., for the hot spot values, the corrections give a general idea of the accuracy of the measurements.

There are a number of manufacturers who can furnish temperature detectors of the embedded resistance or thermocouple type. If M.D. can submit complete information to a manufacturer of this type of temperature measuring equipment, he can undoubtedly obtain something to suit his requirements.

C. O. VON DANNENBERG, *Brooklyn, N. Y.*

Cleaning Antifriction Bearings

Is it absolutely necessary to flush out ball and roller bearings in motors, lineshafts, and machines, that are lubricated from two to four times a year? If it is necessary to wash them out, how often should it be done? What is the best liquid to use? Are there any precautions that must be observed?

A.P.—New York

IF BEARINGS are adequately sealed and protected from dust and grit, and are lubricated at regular intervals, the necessity for flushing out may not arise during the life of the equipment. In those cases where bearings operate in an atmosphere charged with moisture, sand or grit, or where, as in grain milling plants, flour may work into the bearings and form a sticky residue, the cleaning must be done frequently enough to insure trouble-free operation. In such cases the maintenance man usually works out a cleaning schedule that is suited to the conditions.

In the average textile plant where lint particles form a hazard, particularly with motors, the vacuum cleaner and the compressed air blower aid in the weekly cleaning ritual.

Besides kerosene and light oil there are other solutions that can be used to "cut" sticky, worn-out grease and other foreign substances in bearings. They range from hot soda water, as used in the soda kettle in most machine shops, to the various commercial products that can be depended upon to do an efficient

(Continued on advertising page 81)

ANSWERS WANTED

How Interpret These Tests?

A 10-hp., 220-volt, polyphase motor was sent in because anyone touching it while current was on received a severe shock. A 100-megohm insulation resistance meter gave a reading of 200,000 ohms. However, while standing on the wooden floor of our shop I touched the motor, with current on, and got a shock which experience would indicate was caused by a voltage of 60 to 75 volts. After this test a reading of 200,000 ohms was again obtained with the insulation resistance meter. The motor was baked for 8 hours at 212 degrees F., after which the insulation test showed infinity, but still I could not hold my hand on the motor. Eventually the motor had to be rewound. Can someone tell me why an insulation resistance measurement showed 200,000 ohms, while such a ground existed?

A similar question relates to a 1,500-watt, 32-volt lighting plant armature. An insulation test gave a reading of 75 megohms, but when a series test point was drawn across the commutator bars slight sparking was noticeable. After baking the armature for 7 hours an insulation test shows infinity, but tiny sparks are still visible under the series test. No reading is obtained with an a.c. milliameter in the circuit. Two other armatures of the same size and type give the same insulation resistance reading, but do not show sparks under the test light leads. Why? What should be done with the armature that sparks?

B.C.G.—Corpus Christi, Texas

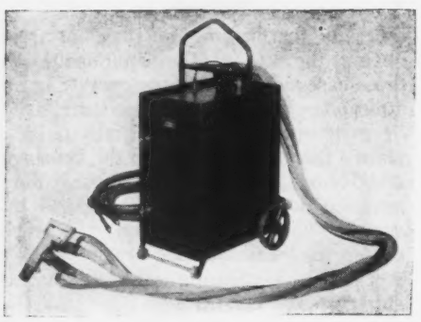
Heating System for Garage

Our garage is built of masonry, one story high, and measures about 142x44 feet. There is no basement below it. I should like to have recommendations as to the most suitable and economical method of heating this building, considering first and operating costs.

R.I.C.—Providence, R. I.

· EQUIPMENT NEWS ·

Welder



Portable, stud. Consists of welding transformer and control mounted in portable steel cabinet, primary and secondary cables, and stud-welding gun. For fusing end of stud into metal surface. Stud is placed in gun, pressed against surface to which it is to be welded and fused with one automatically timed impulse of power. Door in cabinet gives access to control panel for adjusting current and time for different sizes of studs. Gun accommodates studs from $\frac{1}{8}$ to $\frac{5}{16}$ in. in diameter and from $\frac{1}{2}$ to $2\frac{1}{2}$ in. long. Control switch in gun handle for operating automatic timer. Welder obtainable for single-phase power supplies of from 25 to 60 cycles, 110 to 550 volts. General Electric Co., Schenectady, N. Y.

Thrustor

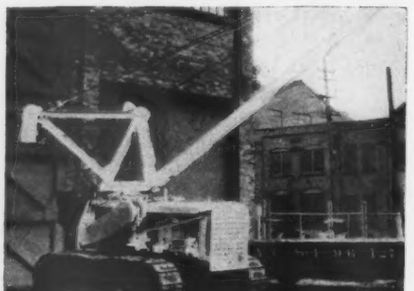
Improvements in line include stationary impeller housing of centrifugal pumps, rigid shaft running in ball bearings connecting impeller to driving motor, availability of a number of driving motor arrangements, a.c. or d.c. All motors are totally inclosed (except d.c. and single-phase motors on 50-lb. size) for protection against dirt and moisture. Interchangeable base plates available for clevis or rigid mounting. Tilting as much as 45 deg. away from vertical permissible, also continuous operation with piston in stalled position. General Electric Co., Schenectady, N. Y.

Pulling Jack

Called "Anchor" Puller - hoist. A lever-operated mechanism using simple principles of leverage. Employs ratchet-toothed, chain sprocket wheel to take up on load chain one notch at a time. Reverse latch for lowering or slacking away. Can be operated in any position —vertical, horizontal, sideways, or upside down. Also useful as temporary chain hoist. Hoist weighs 29 lb.; chain, 16 lb. All working parts inclosed and protected. Capacity, $1\frac{1}{2}$ tons pulling power. Pulling or hoisting speed ranges from 2 to 4 ft. per min. Edelblute Mfg. Co., Reynoldsville, Pa.

Crane

Designated as CT-50 Loadmaster. Powered with Caterpillar 50 gasoline or diesel engine, mounted on modified caterpillar tracks. Has 30-ft. boom and swings through arc of 240 deg. Lifting capacity, 13,900 lb. at 12-ft. radius. Hydraulic stabilizers, mounted between equalizer beam and brackets cast integral with machine frame, provide



stability for crane when operating over side. Tread 20-in. wide. Bucyrus-Erie Co., South Milwaukee, Wis.

Trap

Bucket-type, steam. "TITAN," four sizes, for pressures up to 300 lb. per sq.in. "TINY," two sizes, for pressures up to 150 lb. per sq.in. Lever in top of trap, bearings in clean water protected from wear by scale and grit. Not affected by pulsating pressures; no wire-drawing; handles air and other non-condensible gases. Discharge intermittent under low-medium loads and continuous under high loads. Open bucket is source of power for opening and closing valve. Lost motion between valve and lever claimed to give sudden complete opening, quick tight closing. Adaptable to different pressures by changing seat only. Entire mechanism removable without taking trap from line. Nason Mfg. Co., 71 Fulton St., New York.

Wire Insulation

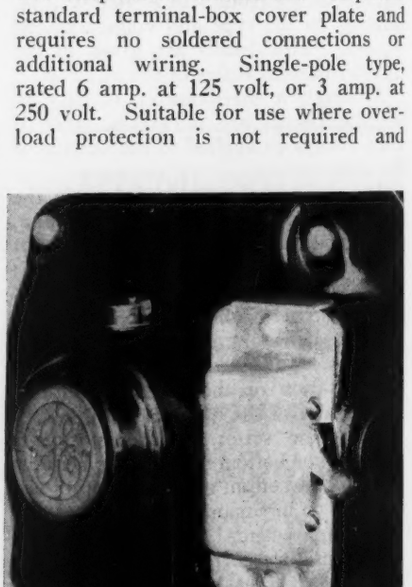
Two types. First employs Cellophane which is wrapped around adhesive-coated magnet wire, then lacquered and baked. Called "Celenamel," and said to save space, have increased dielectric strength, not unwrap when cut or open when bent. Other type employs thin "Duprene" jacket over rubber compound core as protection for ignition cable which must resist heat, oil, and corona conditions. Called Belden 7799. Belden Mfg. Co., Chicago.

Weld Timer

For use with resistance welding machines. Called Folio 2 EC&M, Automatic Weld Timer. Operates on same principle as Folio 1, timing weld with respect to current flow, but contains less apparatus and operates twice as fast. Extra speed permits use of high current with extremely short time on alloys and metals having high thermal conductivity. Folio 2 also equipped with triple current range for refined control of welding time. The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland.

Switch

Motor-mounted, tumbler. For starting fractional-horsepower G-E motors when hand-operated control at motor is required. Device is completely mounted in steel case and provided with positive snap-action mechanism. Replaces standard terminal-box cover plate and requires no soldered connections or additional wiring. Single-pole type, rated 6 amp. at 125 volt, or 3 amp. at 250 volt. Suitable for use where overload protection is not required and



where locked rotor current of motor need not be broken. General Electric Co., Schenectady, N. Y.

Motor Belt Tension Control

For flat-belt, short-center drives. Called "American" Tension Control Motor Base. Designed to produce automatically a belt tension that is always in proportion to the load, increasing the tension when occasional peak loads develop and decreasing it as the power to be transmitted is reduced. Complete range of applications for floor, wall, ceiling, and with attachments for driving downward.

Operates on principle that the frame of the motor is constantly trying to rotate in a direction opposite to that of the motor pulley and with a force (reaction torque), at any given load, equal to that being exerted by the pulley through the belt. This force the manufacturer harnesses by suspending the motor in a cradle free to rotate through a limited range.

The pivot axis of the cradle is placed close to the motor axis in order to obtain the maximum reaction effect, yet far enough removed so that, as the motor swings about the pivot axis, it increases the center distance enough to compensate for belt stretch and to vary the tension with each change in the load. Advantages claimed include: more efficient drive, longer belt life, reduced vibration on intermittent loads. The American Pulley Co., 4210 Wissahickon Ave., Philadelphia.

Blowpipe Head

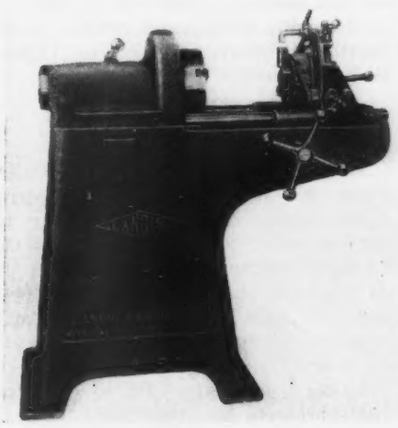
Known as Multi-Flame Lindewelding Head, for use on W-17 or W-22 Oxweld blowpipes. Consists of special chromium-plated stem and tip, available in three sizes, their use depending upon the pipe size. Tip designed to give three flames: Main welding flame and two smaller auxiliary flames, positioned to preheat both edges of the vee ahead of the point of welding. Savings of more than 25 per cent in rod and gases, and 33⅓ per cent, or better, in welding time claimed. The Linde Air Products Co., 305 East 42nd St., New York.

Metal Cleaner

For removing oil, grease, dirt, smut, pigments, and abrasives from metal and other surfaces. Claimed to render all oils and greases readily soluble in water, be harmless to workers, have higher flash point than kerosene. Advocated for cleaning machinery in maintenance work and for pre-cleaning metal parts to be finished. Available as Magnusol No. 73 Solvent (ready mixed) or as Magnusol No. 73 Base to be mixed with kerosene by user. Applied by painting or spraying on surface to be cleaned, let stand few minutes, removed by pressure hose or stream of water. Magnus Chemical Co., 22 South Ave., Garwood, N. J.

Pipe Threader—Cutter

Designed to thread, ream, and cut off pipe and thread bolts and rods. Employs 1-hp. motor and industrial-type control. Motor mounted in inclosed compartment in bed and connected to geared headstock by silent chain drive.



Has one-piece, box-type bed, gear box with three changes of speed cast integral with spindle housing, cross-rail which supports die head and cutting off and reaming tools integral with carriage, scroll chuck of three-jaw universal type. Die heads are quick-opening type and have universal adjustment for size. Two heads with combined capacity of ¼ to 2 in., standard equipment. Tangential-type chasers in die heads retain constant setting for all diameters. Landis Machine Co., Inc., Waynesboro, Pa.

Torch

Roffy, automatic, electric. For welding, brazing, melting, soldering, hard surfacing. Portable, weighs 20 lb., operates on 110 volts, a.c. or d.c. Can be used with two parallel carbons, or single carbon or metal electrode. Transformer provides momentary ionizing current to start arc and subsequently maintains constant temperature through impedance and nichrome ballast. Handle designed to enable operator to adjust flame while in operation, start and stop arc. Normal operating rate, 2 kw. Electric Torch Mfg. Co., 2442 San Pablo Ave., Oakland, Calif.

Grinder

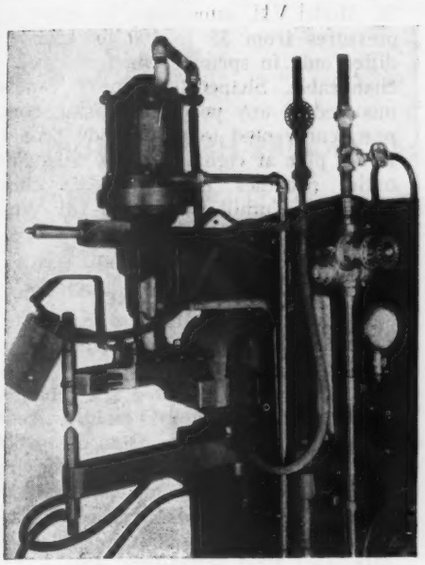
Portable, electric, universal type. Weighs 4 lb., turns up 17,000 r.p.m., has power enough to pull a wheel 2 in. in diameter. Viscous-type built-in air filter, in form of pad, can be removed, cleaned, and re-oiled. Motor housing, cast aluminum, extends over motor shaft and air filter, is incased with insulating cushion grip. Universal, case-hardened chuck. Chicago Wheel & Mfg. Co., Chicago.

Towers—Tanks

H. E. Mott Co., Ltd., Brantford, Ontario, Canada, has purchased assets of Goold, Shapley & Muir Co., Ltd., of Brantford, pertaining to tower, tank, and textile part of business. Manufacture of these lines will be continued in former Goold, Shapley & Muir plant at Brantford by former employees of Goold company, supervised by former Goold executives.

Welder Attachment

Consists of air or hydraulic cylinder mounted on flange of barrel surrounding ram that closes electrodes on manually operated welder. Pressure-regulating valve enables operator to secure pres-



sure desired on electrode. Cylinder may be controlled by hand- or foot-operated valve. Designed to relieve operator of manual exertion of closing electrode and insure correct and uniform pressure for each weld. Cylinder is available in 3-in. diameter and larger sizes. Furnished to fit flange of ram barrel, eliminating necessity of machine work on welder. Hanna Engineering Works, 1765 Elston Ave., Chicago.

Belt Dressing

Liquid. For rubber belts. Claimed to soften the rubber surface without penetrating or deteriorating body of belt. Also said to increase pulley grip and horsepower delivery. The B. F. Goodrich Co., Akron.

Voltage Indicator

For determining socket voltage of lighting system. Consists of Weston Photronic Footcandle Meter, or Sight Meter, together with carbon filament lamp, small composition container, and rubber-covered extension about 1 ft. in length. Carbon lamp housed in container is adjustable by means of lock nut on threaded fibre tube of indicator. Container has five small openings, four on side to facilitate taking of readings, and one at top of indicator cone. In use, indicator is connected to either a.c. or d.c. circuit, bottom placed over photronic cell of meter, and voltage determined by reading foot-candles on meter and checking against conversion scale. G. S. Merrill, Nela Park Engineering Department, General Electric Co., Cleveland.

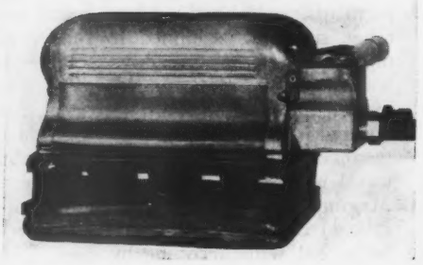
Relief Valves

Model V. In sizes from $\frac{3}{8}$ to $1\frac{1}{2}$ in. for relieving pressures from 5 to 35 lb. Model VH, same sizes, for relieving pressures from 35 to 100 lb. Models differ only in springs, which are interchangeable. Shaped like pipe T, can be mounted in any position. Spring compartment vented to valve body proper. Relief pipe at right angles to inlet and outlet provides freedom from chip-clogging. Tuthill Pump Co., 131 West 63rd St., Chicago.

Circuit Breaker

Low-voltage, "De-ion," with interrupting capacity of 20,000 amp. Called AB-20, is totally inclosed and mounted in standard 600-amp. molded case. Available in all ratings from 50 to 600 amp., complete with standard tripping accessories and motor mechanism. Employs cold cathode principle of arc extinction. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Sanding Machine



Suitable for small shops as well as heavy production lines. Called Sterling Speed-Bloc Sander. Weighs 7 lb., operates on 70 or more pounds of compressed air. (Uses 6 cu.ft. of air per min.) For use on metal, wood, and marble surfaces. Sanding motion is oscillating or reciprocal. Abrasive pad has $1\frac{1}{4}$ in. stroke, between 2,500 and 3,000 oscillations per minute. Pad which carries abrasive paper is made of rubber and felt, bridged to be fully flexible, applicable to convex or concave surfaces. Fitted with water connection for wet sanding, if desired. Length, $7\frac{3}{4}$ in.; height, 4 in., and width, $3\frac{3}{4}$ in. Sterling Products Co., 930 Fox Theatre Bldg., Detroit.

Motor

With built-in speed reducer. Called Type K3-M. Universal-type, $\frac{1}{4}$-hp. motor equipped with single gear reduction unit. Three gear ratios can be supplied from stock—5:1, $14\frac{1}{2}$:1, and 34:1, giving shaft speeds of 1,300, 448, and 191 r.p.m., respectively. Grease-type gear housing forms integral part of motor frame. Gear unit can be positioned on motor case so that gear shaft projects at any desired angle in relation to base (always at right angles to armature shaft). Gear unit fitted with single ball thrust bearing to take thrust of worm. Reverse rotation obtained by fitting motor with ball thrust bearing at end opposite gear unit. Motor has forced air ventilating system, is suitable for continuous duty, weighs $7\frac{1}{2}$ lb. complete with gear unit. The Dumore Co., Racine, Wis.

Battery Testers

Tungar, four-meter. Simultaneously test all three cells of 6-volt storage battery. Model CS-3126718 is equipped with three precision-type voltmeters and a 0-300-ampere meter guaranteed accurate within 2 per cent. When carbon-pile resistance is applied, ammeter registers actual discharge from battery and voltmeters record condition of each cell. Adjustable carbon-pile resistance duplicates automobile starting conditions, showing up faulty cells, according to manufacturer's claims. Device completely inclosed and available for wall mounting or portable use. Also Model CS-3126719, with iron-vane-type instruments, less accurate than precision type, lower priced. Merchandising Dept., General Electric Co., Bridgeport, Conn.

Switches

Two additional sizes in 50,000 line, Type A, include 100- and 200-amp. Standard sheet-metal or cast-aluminum inclosures (cast iron inclosures optional). Have all features of older 30- and 60-amp. switches of this line. Quick-make, quick-break type with interlocked covers and elevated removable bases for easier wiring. Square D. Co., Detroit.

Valves

Industrial, blow. For installation where stationary valve control of compressed air is desired. No. 7796, for bench mounting or for use on light machines, also adaptable for foot operation. Applicable for throwing work out of presses, clearing work benches, removing chips and dust. No. 7854 bolts to machine frames for heavy-duty mechanical operation. Suited for power presses, eyelet machines, automatic screw machines, or where intermittent blast of air is required to clear work, remove chips, or discharge completed work. Extra heavy construction. Available for either direct plunger action or with lever. A. Schrader's Son, Inc., Brooklyn, N. Y.

Trade Literature

AIR COMPRESSOR — Bulletin L-620-B7A, Type VA-2 air compressor units.—Worthington Pump & Machinery Co., Harrison, N. J.

BELTING — Bulletin, "Tension Welded Leather Belting."—Chicago Belting Co., 125 N. Green St., Chicago.

CABLE—Leaflet, "Lead Encased Building Wires and Cables."—General Cable Corp., 420 Lexington Ave., New York.

CASTINGS—Folder, "700,000 Miles," on "Shock Proof" malleable castings.—The Lake City Malleable Co., 5016 Lakeside Ave., Cleveland.

CASTINGS—Reprint, "Zinc Die Casting Alloys Aging Data."—The New Jersey Zinc Sales Co., 160 Front St., New York.

CHEMICAL PRODUCTS—Catalog, contains wide range of information, including nearly all scientific facts needed to determine

(Continued on advertising page 88)

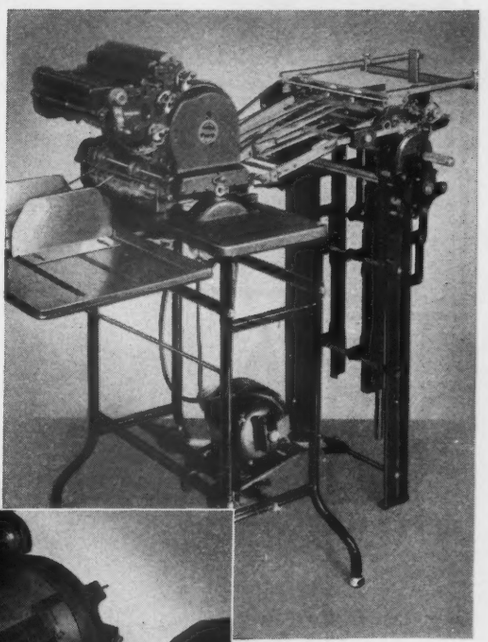
for more accurate, less costly FACTORY PRODUCTION CONTROL

MANUFACTURING organizations using the Multigraph method of Factory Form Writing report substantial savings of time, money and floor space—increased efficiency—decided reductions of waste due to errors.

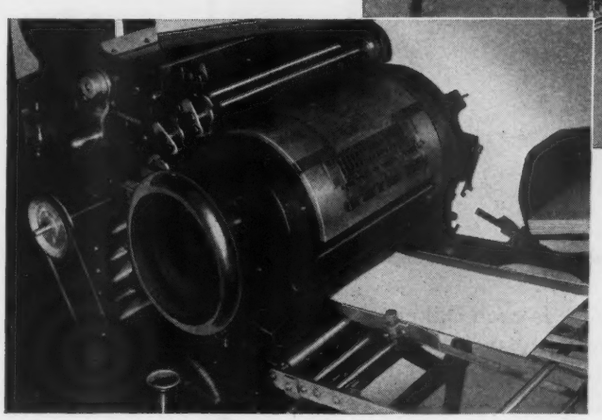
The Multigraph provides a swift, accurate and economical means of producing Specification Data, Material Lists, Manufacturing Instructions, Production Orders, Piecework Labor Coupons . . . often printing several of these forms in combination *at one impression.* Production forms produced on the Multigraph greatly aid in the coordination of manufacturing detail, and can be kept up to date constantly at small cost.

As many original copies of production orders and specifications may be printed as desired—a distinct advantage on complicated operations where legibility is of vital importance. Only orders required for each day's work are printed—no obsolescence.

Many factories report savings of 25% of previous costs, with the additional advantage of speeding the start of work into production. Multigraph also effects economies in the Cost, Payroll, Sales and Advertising Departments as well as in Manufacturing Departments—another evidence of its flexibility and versatility. Our trained representative, who is regularly in your vicinity, will gladly furnish you specific details of the profit-making possibilities which Multigraph can bring to your business. Consult your 'phone book, or write us.



Right: The Printing Multigraph . . . one of 50 standard models . . . is used for printing production orders and piecework tickets, as well as general office forms as needed, speedily and economically.



Left: A close-up view of the special printing unit showing flexible blanket type form for constant manufacturing information, and numbering wheels for inserting variable information at same impression.

THERE ARE MORE THAN 50 MODELS IN THE MULTIGRAPH LINE, INCLUDING OFFICE PRINTING, LITHOGRAPHING, TYPESETTING AND FOLDING MACHINES. PRICES AS LOW AS $145.00

MULTIGRAPH COMPANY
Division of
Addressograph-Multigraph Corporation • Cleveland, Ohio

Multigraph
TRADE MARK

MULTIPLE TYPEWRITING AND OFFICE PRINTING

MULTIGRAPH PRODUCES:

1. Office and Factory Forms.
2. Circular Letters and Bulletins.
3. Price Lists and Quotations.
4. Direct Mail Advertising.
5. Letterheads and Envelopes.
6. Booklets, Folders, Inserts.
7. Messages on Post Cards.
8. House Organs and Notices.
9. Complete Personalized Letters.
10. Cartons and Cellophane Wrappers.
11. Instruction and Parts Booklets.
12. Display and Price Cards.
13. Gummed Stickers and Labels.
14. Illustrated Catalog Pages.

High enough for multiple tiering

Low enough for a box car door

Built for economical operation under the most severe conditions

...Type IMF tilting, chain hoist, fork truck will pick up, carry, and stack tinplate, boxes, bales, or pallet-packed or bundled material.

NEW

NOT only is each Baker engineer thoroughly trained to analyze material-handling problems and assist in the proper selection of equipment, but he is also using that training daily in installing material-handling systems in the largest plants. Isn't it just good judgment to call in a Baker engineer before you decide on a material-handling system?

The Baker Industrial Truck Division
of THE BAKER-RAULANG COMPANY
2178 West 25th Street •• *Cleveland, Ohio*

Baker

Unemployment Insurance? It's Coming

(Continued from editorial page 447)

"Frankly, I see no reason why society at large should have to stand the burden of supporting the employees of that seasonal business, or of this fluctuating manufacturing business, instead of letting the full cost show up in the price we must charge the public. If this makes our products cost more than the public will pay, that proves we are not economically justified in existing—and it is right we be forced out of business. Of course, this won't happen. What will happen is that we shall find ways to prevent this economic waste we now complacently tolerate because we do not feel its direct cost.

"But this, it seems to me, is the essence of why, if any unemployment insurance scheme is correct, this Wisconsin method is preferable. Suppose, to continue with the two companies just cited, the manufacturing company succeeds in stabilizing its employment, while the seasonal business goes on as before. Under the present provisions of the law, the factory will finish up its monthly payments in three or four years, and then can sit tight with no additional cost. But every year the seasonal business has to dip into the treasury for 2 per cent of its payroll. That is just. Our manufacturing business should not, and under the Wisconsin type of law does not, get penalized for the economic misdeeds of the seasonal employer. And each feels directly the incentive to do a better job of stabilizing.

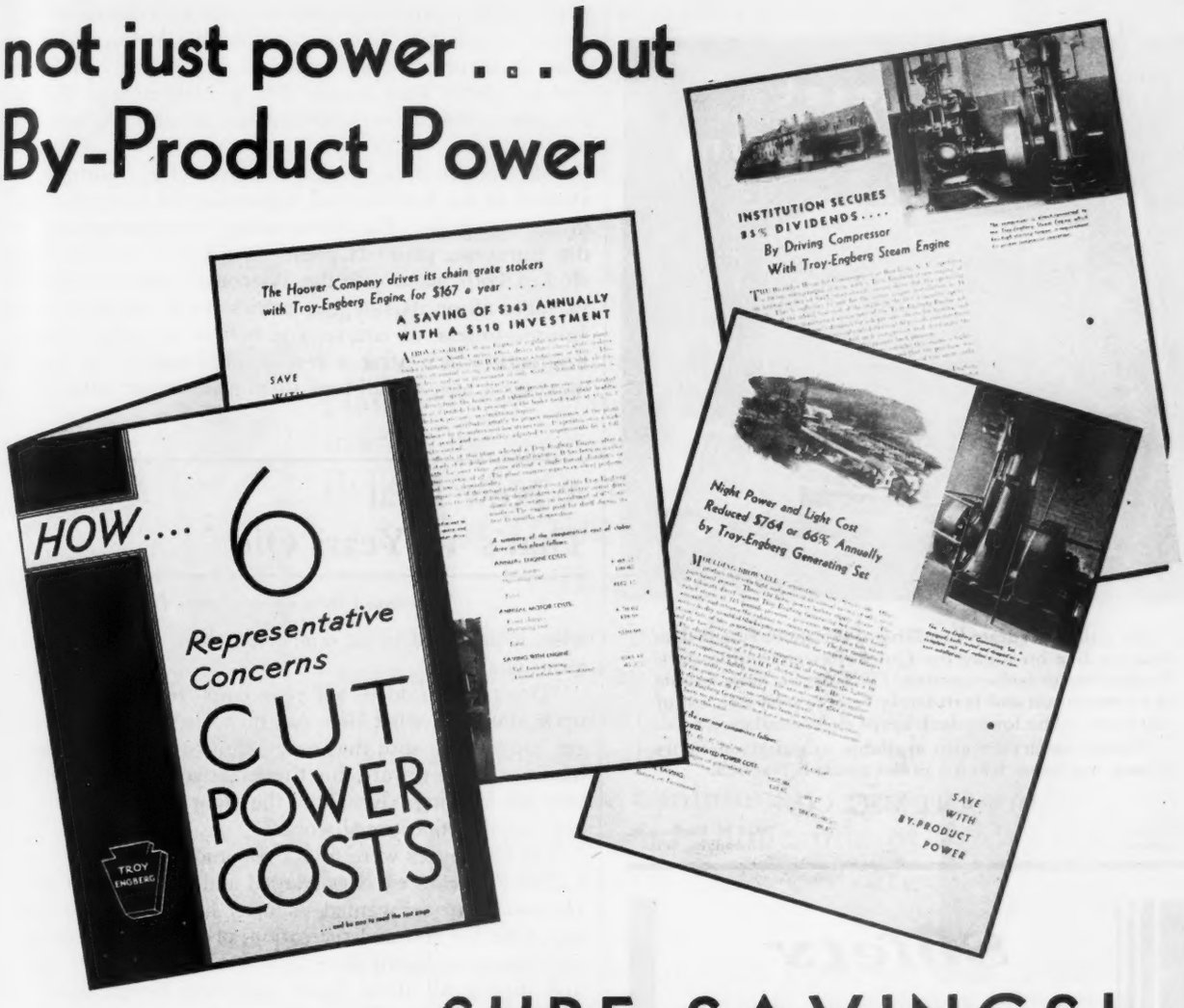
Reserves vs. Insurance

"Contrast this with the European, or Ohio, plan whereby the employer, the employee, and the government all contribute to a central fund. What our manufacturing company does to decrease unemployment will have no appreciable effect on what it has to pay into the fund. Neither will my brother's seasonal business's behavior. So they both go blithely on their way, letting out help when it seems economical. We do not lick unemployment, merely provide a palliative. And our factory—which has always been a steadier employer than my brother's little business—is assessed regularly to pay for my brother's seasonal misdeeds as employer.

"Again, with each employer's reserves in a separate fund, the employee sees its limitations. If it is in a pooled fund held by any government official, it seems to have behind it the entire Treasury. When the fund approaches exhaustion, government funds will be demanded to replenish it—and yielded, for political if no other reasons. The thing will become a political football, as it has long since become in every European country where it has been tried.

"In short, what we have in Wisconsin is unemployment reserves; what they have in Europe is unemployment insurance. I see a lot of possible benefit from reserves, but nothing but grief if the nation or any individual state goes over to insurance. The Wisconsin method is predicated upon the idea that something can be done to prevent or minimize fluctuations in employment. The European plan, which its advocates claim is the only way

not just power . . . but By-Product Power


The Hoover Company drives its chain grate stokers with Troy-Engberg Engine, for $167 a year . . . .
A SAVING OF $343 ANNUALLY WITH A $510 INVESTMENT
INSTITUTION SECURES 85% DIVIDENDS . . . .
By Driving Compressor With Troy-Engberg Steam Engine
Night Power and Light Cost Reduced $764 or 66% Annually by Troy-Engberg Generating Set
SAVE WITH BY-PRODUCT POWER
HOW 6
Representative Concerns
CUT POWER COSTS
TROY ENGBERG

SURE SAVINGS!

Pause for a moment and get the real significance of the savings mentioned above. Each company adopted a certain idea. Each made a small investment. Each is enjoying right along a large annual return on that investment.

By-Product Power is the idea. A Troy-Engberg Steam Engine or Generating Set is the investment.

In this logical move of yours to look for possible cost-reductions in the power end of your operations, don't confine your search to just the boiler room and main power units. Study By-Product Power and see what it can do for you. If you use steam for processing or heating anywhere in your plant, you too can probably enjoy similar savings . . . or cost-reductions.

So, **today,** do two things. Send for the detailed report telling how these six companies (and hundreds of others) are making substantial savings by means of By-Product Power. Also, have your engineer send us an outline of your steam and power requirements for a preliminary estimate of the savings that can be made in your plant.

TROY ENGINE & MACHINE CO.
346 Railroad Ave., Troy, Penna.

TROY-ENGBERG

COUPON

return to TROY ENGINE & MACHINE CO., Troy, Penna. F. 10-34

Please send us detailed report showing how six companies cut their power and steam costs by using a Troy-Engberg Steam Engine or Generating Set as a By-Product Power unit.

date .....

Name .....

Company .....

Address .....

For quick, accurate handling of the short run orders that we live on today the Quick-Reset, Double-deck *Productimeter* is the counter. The upper deck counts the current run and is instantly reset to 0 by a throw of the lever. The lower deck keeps the cumulative total.

***Productimeters* are also available to signal operators or stop machines when a preset count is reached.**

DURANT MFG. CO.

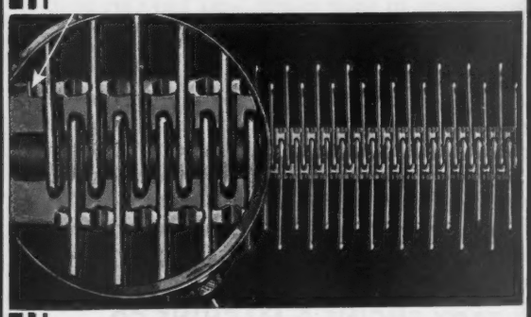
176 Eddy St.
Providence, R. I.

1918 N. Buffum St.
Milwaukee, Wis.

Safety
REG U.S PAT OFF

BELT HOOKS

SEE THOSE STEEL BINDER BARS



The bars make every strip of hooks a UNIT. So, no waste—no loose hooks to injure hands. Easily cut to fit any width belt. Fit any standard belt lacing device. Binder bars prevent hooks breaking loose and fraying over belt edges. Perfect and sustained alinement of hooks, hence even, steady pull. Proved more efficient. Endorsed and sold by leading mill supplies jobbers. Sample for examination free from your jobber or direct from

SAFETY BELT-LACER CO.
FACTORIES BLDG. TOLEDO, OHIO

to give the employee adequate benefits in economic stress, seems resigned to the assumption that nothing can be done to reduce unemployment, therefore we had better just go ahead with a plan that will indemnify the innocently suffering employee when he gets thrown out of a job.

"My sincere hope is that employers the country over awaken to the fundamental importance of this difference in the two plans. The more radical elements are all for the European plan. It seems to a lot of us who have studied both plans that the Wisconsin plan has the advantages all on its side and carries fewer threats for the future—unless, of course, you believe in unemployment insurance which after a few months will in any major depression have to fall back upon government funds."

A New Deal That's 40 Years Old

(Continued from editorial page 453)

what it proposed to do, and what their part in the program would be.

"Don't be afraid to tell your employees what you are up against and what they can do to help. If you would get support, be sure that every plan to help the business has in it some reward for the employees, whose support you are seeking. Keep on the floor and everlastingly keep up the educational work."

The employees were told a few months ago:

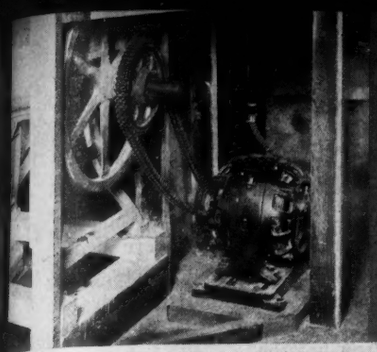
"For 40 years we have wanted and have tried to secure for you what you wanted—shorter hours of work, better pay, time for rest and recreation, protection during times of sickness, a decent place to work, to play and to eat in, and during all these years you have never asked for impossible things. We shall not change during coming years, but will continue to want for you what you want."

Shorter hours, higher wages, and better working conditions were not forced upon the company by public sentiment, legislative enactments, or any form of intimidation or threat. Working conditions have been voluntarily improved as rapidly as the earnings of the company and the cooperation of the employees justified.

'Way Back in 1906

Just to show that Mr. Dann's philosophy is no new thing with him but has persisted through many years, excerpts from a speech he gave in 1906 before the annual meeting of the Laundry-Owners National Association are enlightening. Away back there he said that the company had derived great benefits from the factory committee, comprised of one employee from each department, which met every week to discuss mutual problems with the management, and solved many perplexing questions. There was also a bi-weekly meeting of supervisors to discuss their problems. This was the forerunner of the present employee representation plan which includes a committee of salesmen representatives and one of factory representatives who combine in a joint council with the management for discussion and decision on all problems of mutual interest.

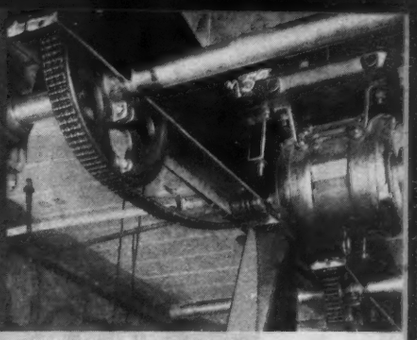
Pilgrim employees, he reported, were getting out more



One of thousands of Diamond Chains in the usual everyday motor drive service—5 h.p. 1500 r. p.m.motor, driving grinding mill—double strand Diamond Roller Chain—always dependable, no slip nor slippage loss, low in maintenance expense, quiet—and long lived.

STOPPING POWER WASTE ON EVERY MOTOR DRIVE

Is the Same as Increasing Profits on Sales



Quietness and high efficiency are important features of Diamond Roller Chains for factory drives and they are easy on shaft bearings because one side is always slack. One of group of 15 and 20 h.p. Diamond Triple Strand drives in textile mill.

Every dollar saved on motor and machinery drives is a full hundred cents saving.

There are power wastes in every plant—in *your* plant—that can be eliminated by greater use of Diamond Roller Chain Drives.

Longer life in addition to high efficiency means yearly savings. This 7½ h.p. 1750 r.p.m. Diamond Roller Chain drive outlasted three drives of another type under identical conditions.

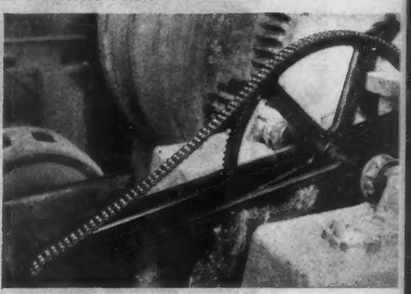
Cut YOUR Power Bill —This Way

You can cut down your power bill for every day you operate because Diamond Drives perform year in and year out at the high maintained efficiency of 98-99% and require a minimum of upkeep. Thousands and thousands of Diamond Drives in daily use are proving this.

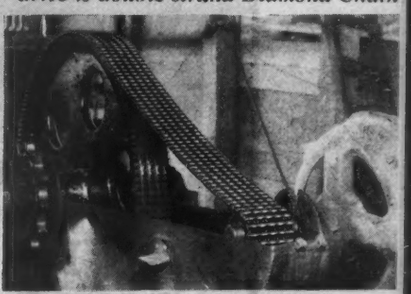
When you hook up with compact Diamond Chain the driven machines will turn out the production unfailingly and at the maximum rate selected—not only for the first week or month—but for *every* hour and *every* day. There is no slip nor slippage loss.

Decide to recover the dollars of lost power that you have right in your plant. Stopping power waste is a *net* saving.

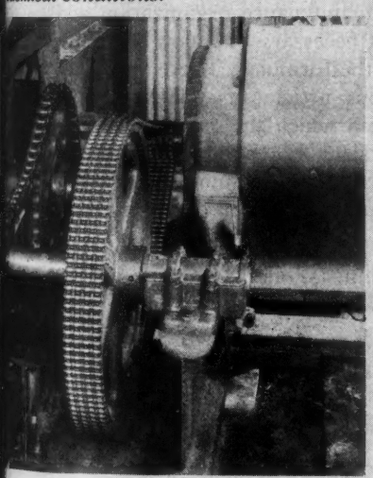
Diamond Anti-friction Roller Chain Drives are fully described in our new catalog 583. Diamond Chain & Mfg. Co., Indianapolis, Ind. Offices and Distributors in All Principal Cities.



There is always dust and dirt around a ceramic plant — but Diamond Roller Chain is not affected by dust, fumes or weather. This 5 h.p. 1500 r.p.m. motor drive is double strand Diamond Chain

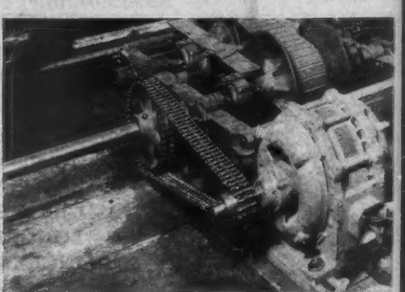


Foundries need drives that stand up and cut power losses, too. When this Diamond quintuple strand chain drive was installed—its performance and saving led to replacement of other types of drive by Diamond also. 20 h.p. 1160 r.p.m.



A good example of quadruple strand and single strand Diamond Drives. The quadruple strand chain is ¾" pitch No. 433 from 30 h.p. motor to jackshaft, 19 to 126 tooth sprockets. Single strand chain (2" pitch) jackshaft to machine.

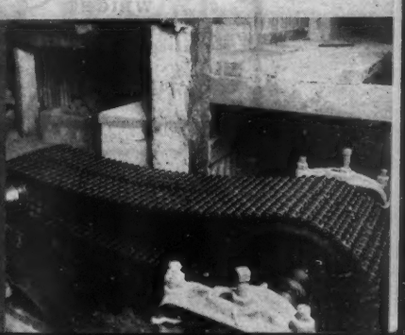
For heavy work, drives must be able to "take it," and this Diamond Chain 50 h.p. 1160 r.p.m. drive has been in service long enough to prove its superiority over the drive it replaced.



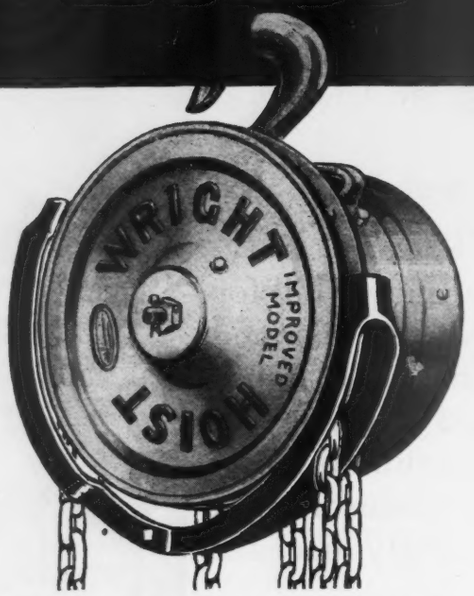
Diamond Drives, because of their high maintained efficiency and positive speed ratio, are particularly suitable in connection with speed reducers.

Cotton ginners watch every cost carefully—this multi-strand Diamond Roller Chain drives a cotton gin from a 12 h.p. 880 r.p.m. motor at high maintained efficiency.

DIAMOND ROLLER CHAIN DRIVES



AN *Improved* WRIGHT HOIST



21 POINTS OF SUPERIORITY

In all capacities
300 Pounds to 40 Tons

Master engineering—scientific design—finest materials—backed by long years of experience have gone into the development of the new, improved Wright High-Speed Chain Hoist.

In the new Wright Hoist there are 21 points on which it is superior to all former models. Summarized, those 21 points mean:

1—GREATER EFFICIENCY
2—LONGER LIFE
3—INCREASED USEFULNESS

Send for an illustrated catalog showing a cutaway view of the new Wright Hoist. See for yourself why the 1934 Improved Wright is sturdier, more efficient and positively rust-proof.

Remember—no advance in price.

WRIGHT MANUFACTURING DIVISION of AMERICAN CHAIN COMPANY, Inc. • York, Penn.

ACCO

work with less floor space and machinery; while payrolls had been increased 25 per cent during the year, dividends had also been increased. The Mutual Aid Society was in operation then, vacations with pay were being given, food was being sold at cost to employees, and organized entertainment was being provided through the employees' own efforts.

The reasons given in 1906 for all this apparently extra expense for what was then called "welfare work" are the same as those given today. These things were being done with a desire to raise the efficiency of employees through better working conditions and education. This added efficiency would increase dividends and make possible increased wages, shorter working hours, and improved conditions, because the most substantial foundation upon which one can build is a strong, efficient, and conscientious organization.

Check Your Maintenance Costs With This Simple Formula

(Continued from editorial page 469)

the total hours involved (total maintenance hours minus hours allocated in parts one and two of the formula) by the total replacement value of machinery and equipment in the active plant account. The result is

$$0.001653 —, \text{ or } \frac{1}{605}.$$

There are principles of maintenance organization and procedure that I consider it necessary to follow to secure the efficiency demanded by the formula. These principles were outlined in a previous article (*F.M.&M.*, Sept., 1934). The six plants from which the data were taken were so organized and operated. Later the other eighteen plants were put on the same basis. The number of workmen in the twenty-four plants was broken down into four groups:

M = maintenance, machinists, oilers, machine inspectors, blacksmiths, ironworkers, welders, tinsmiths, tool-mold-die repairmen, helpers.

C = carpenters, millwrights, pattern makers, masons, painters, helpers.

P = pipers, plumbers, helpers.

E = electricians, motor inspectors, sub-station attendants, helpers.

And the analysis showed:

	M	C	P	E
For each 400,000 sq.ft. of floor space	0.4	1.6	0.2	0.4
For each 220,000 lb. of prod. per month	0.56	0.31	0.15	0.08
For each $1,260,000 replacement value of machine and Equipment in active plant account	5.4	1.3	1.4	1.2

To check the averages with the formula, use the data given in the example in the first part of the article.

$$M = \frac{308{,}000}{400{,}000} \times 0.4 + \frac{600{,}000}{220{,}000} \times 0.56 + \frac{408{,}000}{1{,}260{,}000}$$

$$= 3.59$$

By the same method,

$C = 2.50$, $P = 1.03$, $E = 0.94$

Total = 8.06

(Continued on page 82)

(Continued from editorial page 475)

job. Precautions to be observed vary according to the nature of the cleaning agent. With kerosene the fire hazard must be recognized. In the case of other solutions it may be necessary to protect the eyes and clothing from strong chemicals.

ROBERT S. ALEXANDER
Providence, R. I.

Motor Reverses Rotation

Can someone tell me why a 5-hp. compound, d.c. motor that drives a woodworking machine reverses its direction of rotation just before it reaches normal speed? This motor had not been in service for some time; so when we had use for it recently it was completely overhauled. When we tried to operate it after it had been installed it seemed to start all right but before it reached full speed it stopped and began to run in the opposite direction. At the same time, the fuses blew. The same thing happens every time we try to start it, although the fuses do not always blow. The motor seems to be in good condition otherwise, and I should like to know how to keep it going in the proper direction. R.D.—Birmingham, Ala.

MY EXPERIENCE indicates that the field coils of the motor are of opposite polarity. Hence the motor has a differential, instead of a cumulative, connection. Unless care is exercised when a compound motor is overhauled this error is likely to be made.

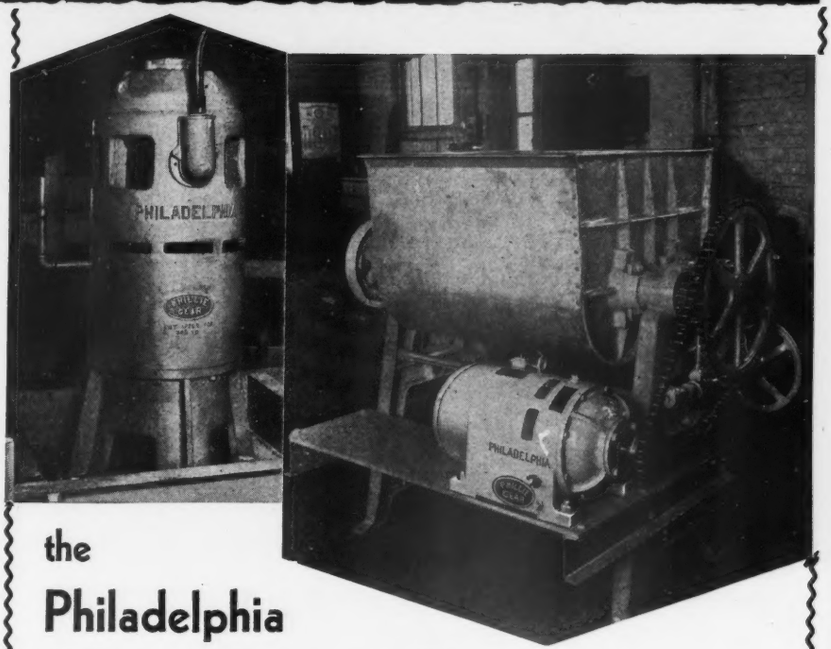
Series and shunt field coils of opposite polarity in a compound motor may produce several effects, depending on the strength of the series field. For example, the motor may start and operate satisfactorily under no load. When the load is applied the motor may suddenly increase its speed and spark badly at the brushes. Or, the motor may decrease its speed and, if not properly fused, stop, reverse, and run in the opposite direction.

To test the polarity of series and shunt field windings, disconnect one side of the shunt field; then start the motor as a series machine and note the direction of rotation. Do not cut out the starting resistance, or the motor will reach a dangerous speed. If the motor is started manually, close the switch and move the arm of the controller to the first contact. Hold it there for a moment, note the direction of rotation, and allow the arm to drop back to the Off position.

If the motor is started automatically, block out all accelerating contactors so as to allow only the line contactor, with all starting resistance inserted in the armature circuit, to close. Note the direction of rotation and then pull the line switch to stop the motor. Indicate the

(Continued on page 84)

SPACE SAVING · · · · ·
· · POWER SAVING · ·
· · · · · MONEY SAVING



the
Philadelphia
MOTOREDUCER
meets all these requirements

The battle cry of industry continues to be — "CONSERVE." New equipment and new methods justify their adoption only when they result in a saving. The Philadelphia MotoReduceR saves in many ways. First — it SAVES SPACE, because it is compact. Motor and speed reducer are combined in a single housing, eliminating the need for a separate base plate, flexible coupling, etc. Then - it SAVES POWER, with efficiencies up to 97%.

Long service life with low upkeep — minimum time and labor required for installation — totally enclosed, thus preventing accidents — all these go to make the MotoReduceR a real MONEY SAVER.

We are preparing a booklet containing views of some of the hundreds of MotoReduceRs installed (both horizontal and vertical types). It also contains full descriptions and other technical details of the units. May we send you a copy?

The installation views above show: At right—Horizontal MotoReduceR operating meat chopper in a food manufacturing plant. At left—Vertical MotoReduceR driving mixing tanks in large paper mill.

PHILADELPHIA GEAR WORKS
Industrial Gears and Speed Reducing Units
Main Office and Works—Erie Ave. and "G" St., Philadelphia, Pa.
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Yes sir!

and

CLING-SURFACE

will reduce *your* Power Losses

Manufacturers who are running their belts slack and preserving them with Cling-Surface are not concerned over power losses. They have found from actual tests that this combination saves them many dollars every year in actual belting costs, lower lubrication cost on bearings, reduced shaft strain and less power consumption. Ask your mill supply house for proof or write—

CLING-SURFACE COMPANY
1058 NIAGARA STREET BUFFALO, N. Y.

(Continued from page 64)

This means that the maintenance group should have 8 workmen: 3 in the machine group, 2 in the carpenter group, 1 in the pipe group, 1 in the electrical group, and 1 (helper) working in both the M and C groups.

The maintenance labor expense for this plant, according to the formula, should be $971.77 for the month. This amount, divided among eight men, gives an average earning of $121.47. I further specify the hours per man per month; that the group should be in one shop; that any man should work on any job when necessary; and that the master mechanic of the plant should act as foreman for the group.

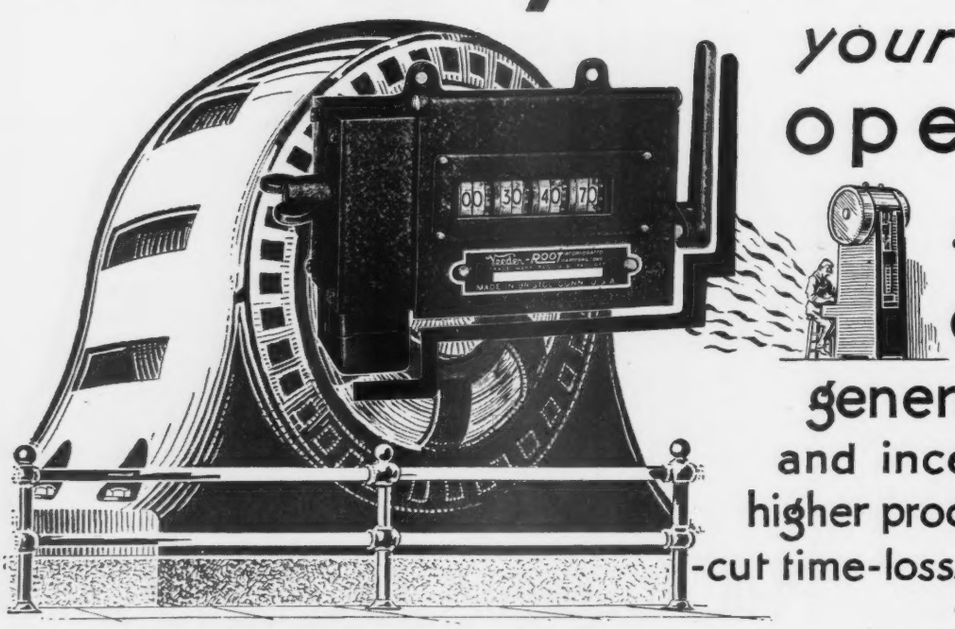
This formula was found to apply as a very good check in all the plants, regardless of size or type of production, except in the plants operating more than one shift, where it was found necessary to add 10 per cent to the result obtained, for each full shift over one, due to night use of equipment and added maintenance supervision.

Maintenance Materials—From the analysis of the work orders at the six plants it was found that total maintenance material cost was approximately the same as total maintenance labor cost.

Maintenance Overhead—Total maintenance overhead expense (including maintenance supervision, share of engineering expense, and charges for use of maintenance building space and equipment) averaged 38 per cent of total maintenance labor cost at those plants.

Total Maintenance Expense—Therefore, total maintenance expense should approximate 2.38 times maintenance labor expense as found by the formula.

More power to
your machine
operators



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COUNTERS
generate energy
and incentive to make
higher production-records
-cut time-loss, material-waste.
Ask about their applications.

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To those manufacturers who recognize the possibilities for profits from reduced power and processing costs by installing modern machinery ... Worthington offers a comprehensive line of modern, efficient equipment developed upon the accumulated successful experience of over 90 years in the power service field, with the advice of qualified Worthington engineers to assure the correct selection for every condition.

In a variety of services for the steam plant . . . in compressed air service of every type . . . in innumerable pumping applications for process or water supply . . . in refrigeration and air conditioning . . . in the generation of power . . . in power transmission . . . *Worthington equipment has built a reputation throughout the world for unsurpassed performance and economy in every field and service.*

DIESEL AND GAS ENGINES
AIR AND GAS COMPRESSORS
FEEDWATER HEATERS
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STEAM CONDENSERS
V-BELT DRIVES
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UNFENCED NEXT DOOR

But CYCLONE FENCE KEEPS OUR PLANT SAFE

"Originally we put that fence up to stop petty thieving by having complete control of exits and entrances.

"Then we found it allowed us to put one of our night watchmen on a new job as warehouse man. The fence allowed us to keep our weather-proof stock in the yard thus providing added storage space.

"Next we noted we had no more loafers or unwanted visitors, thus avoiding possibility of injuries and consequent liability.

"Then came that riot in the next plant—but we needn't go into that.

"Our fence has been up several years now and apparently will be up for many more. That means the cost per year is and will be very small. It paid us to check over the claims, reputation and prices of Cyclone Fence Company before we had this fine job installed by a trained Cyclone crew and with no worry to ourselves."

A Cyclone Chain Link Fence, in spite of its low cost, provides a permanent safeguard, with virtually no upkeep expense. You may become familiar with its many advantages without obligation. Today, write for complete information. Address Dept. F. M.

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Pacific Coast Division:
Standard Fence Company
Oakland, Cal.
Cyclone—not a "type" of fence, but fence made exclusively by Cyclone Fence Company and identified by this trade-mark.

(Continued from page 81)

direction of rotation with an arrow on the frame of the motor.

Connect the shunt field and short-circuit the series field connection. Start the motor again and note the rotation. (The precautions necessary with the shunt field disconnected need not be observed when checking the direction of rotation with the series field shunted out, since the motor is now operating as a shunt machine and should not accelerate to a dangerous speed.)

If the direction of rotation is opposite to that produced by the series field, the series and shunt field coils are of opposite polarity. To remedy, interchange the leads of whichever field does not give the desired direction of rotation.

F. H. BLANCHE, *Trenton, N. J.*

WHEN the motor was reassembled after overhauling, one of the fields probably was reversed so that now the two fields "buck" each other. It is quite likely that the shunt field is reversed.

In starting, the series field is the stronger and starts the motor in one direction. When the motor picks up speed the counter-e.m.f. builds up and the armature current drops, allowing the shunt field to overcome the series field, and the motor reverses its rotation. The heavy inrush of current when the motor reverses with no resistance in series with the armature blows the fuses.

If after reversing the shunt field the motor runs in the wrong direction both the shunt and series fields will have to be reversed. Do not reverse one field without reversing the other, after the trouble has been remedied.

W. M. KELSEY, *Fishersville, Va.*

IT LOOKS very much as though the series field and the shunt field connections of this motor were made incorrectly at the time the motor was overhauled. There is little doubt that the connections have been made so that the series field and the shunt field are "bucking" each other. In other words, they are connected so as to give opposite polarites.

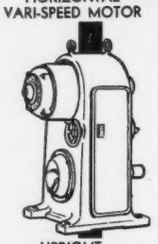
During the early part of the starting period the heavy starting current flowing in the series field winding is so great that the series field flux overcomes that of the shunt field and causes the motor to start in one direction. After the motor is nearly up to speed the starting current dies off and the series field flux weakens, with the result that the shunt field flux overcomes that of the series field. Hence, the shunt field predominates, but in the opposite direction. Therefore, at this point the motor reverses its rotation.

To remedy the trouble, either the series field or the shunt field should be reversed, so that the polarity of each will be the same.

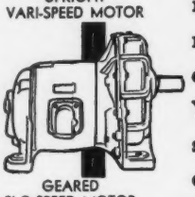
R. P. GUILDFORD
General Engineer
Westinghouse Electric & Mfg. Co.
Philadelphia, Pa.

SYMBOLIC OF MODERN DESIGN

HORIZONTAL VARI-SPEED MOTOR



UPRIGHT VARI-SPEED MOTOR



GEARED SLO-SPEED MOTOR

SQUIRREL CAGE PROTECTED MOTOR

In Sterling's complete motor line you will find new ideas, new designs, new applications never before available. You will find speeds you want, compactness you need and correct prices essential to economical installations.

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Boston	Philadelphia	Pittsburgh
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Sterling MOTORS
DIRECT POWER APPLICATION STERLING SYSTEM

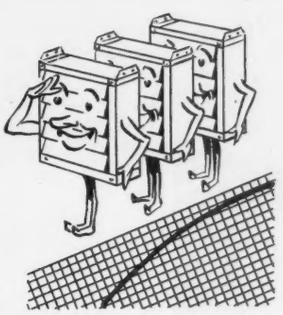
NOT spectacular, but of PROVEN Economy, Reliability and Durability

STRONG? CERTAINLY!

"A heater coil *must* be strong—at least, strong *enough!* Since 250-lb. steam pressure is the maximum I'll have to handle, I'm plenty strong enough for that—in fact, I'm guaranteed to handle it. It's been years, really, since a member of the BREEZO-FIN family suffered from weak coils, but probably some folks still worry about them."

EFFICIENT? WHY NOT?

"After all, there are only two important parts to a unit heater,—the coil and the fan. My coil is the light-weight, copper-finned, non-corrosive high-efficiency type. My fan is the BREEZO, the *quiet* fan with the large capacity and low power consumption. Putting these two things together, why shouldn't I be efficient?"



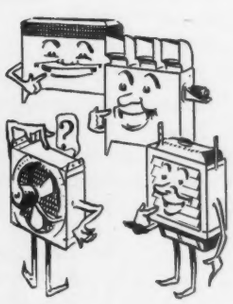
QUIET? SURE!

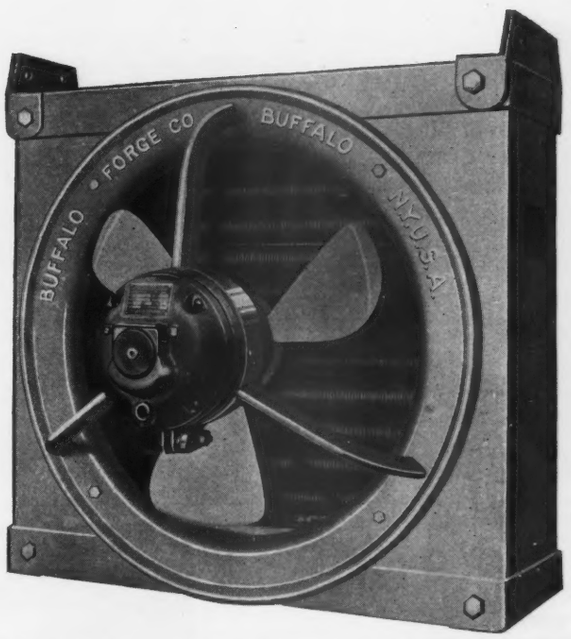
"I can be as quiet as you like—so quiet that you won't know I'm running. Speed for speed, I'm a little quieter than most other unit heaters because of my fan design, curved-blade wheel and streamlined entrance ring. However don't worry about noise! Check me against any heater made and I'll pass the test!"

ECONOMICAL? NOT ALWAYS!

"Now, here's one place where I'm an exception! I do NOT think that I can handle every heating job! Altho I'm the oldest member of the Buffalo family, I frequently give way to a Buffalo Highboy or Lowboy, or Gas-Fired Unit, when there's a job where those units are more practical and economical."

"Surprising what a difference it makes to the user when he can have just the RIGHT units for his particular job!"





BREEZO-FIN Unit Heaters make no claims to "super-this" or "super-that"! They ARE practical, highly economical units built to HEAT with a minimum of attention, and a maximum efficiency. The fact that it has not been necessary to change the design of heater coil or fan for several years is an indication that BREEZO-FIN Units are satisfactory and acceptable in the REAL Testing Laboratory—in service!

Complete range of sizes and capacities, of course, as well as several other types, which in some cases, prove to be more satisfactory.

WRITE US FOR BULLETIN No. 469

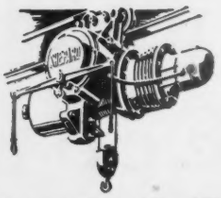
BUFFALO FORGE COMPANY

Buffalo, N. Y.

In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" BREEZO-FIN Unit Heaters

also Floor Type, and Gas Units



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Electric Hoists

Exclusive Features: **1. Balanced Drive, at two points diametrically opposite. 2. Perfect alignment, maintained by all parts rotating around a common axis. 3. Automatic Oil Bath Lubrication. 4. Control by rope, push button, outrig or controller for every hoist. 5. Precision variable speed control for both A. C. and D. C. 6. Variety of speeds, types, lifts and capacities precisely suited to any service.** *Write for complete data.*

SHEPARD NILES CRANE & HOIST CORPORATION
364 SCHUYLER AVE., MONTOUR FALLS, N. Y.

Why Do Holding Coils Burn Out?

Burning out of the holding coils of two 440-volt, three-phase magnetic switches has caused us much trouble recently. These switches, which are rated 15 and 25 hp., respectively, are several years old, but gave us no trouble until about a year ago. Then the coil in one switch burned out suddenly. Shortly after it was replaced the coil in the other switch failed. Each coil has burned out two or three times since then. These switches have been carefully inspected and are in good condition. They seem to operate properly until the coils burn out. The only unusual action I can notice is that sometimes these switches hum. What is the cause of these burn-outs, and how can I prevent them? A.K.E.—*St. Louis, Mo.*

OCCASIONALLY I have had trouble with a.c. holding coils burning out, and I believe that the explanation is as follows: The only limitation upon current flow in a d.c. magnet is the resistance of its winding. This is not true with an a.c. holding coil, because of the reactance of the coil. The reactance varies with the air gap; that is, the closer the armature comes to the core, the greater the reactance. Hence, the current decreases as the armature is pulled up, which makes the sealing-in pull less than it would be for a d.c. magnet.

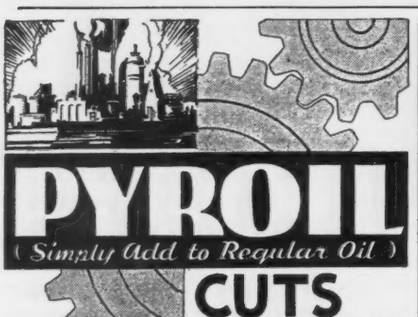
It is obvious, therefore, that any tendency to prevent the armature from sealing in perfectly will cause a greater current flow, and therefore raise the temperature of the coil. If this condition goes unnoticed for a considerable time it will result in the coil burning out.

To avoid such conditions the armature and core of the holding coil should be inspected occasionally to insure perfect sealing. Care should also be taken to see that, when a coil is replaced, an exact duplicate coil is installed and fits tightly on the core.

PAUL LINDHOLM, *Newark, N. J.*

What Alloy Will Stand Zinc Sulphate Solution?

We use steam pumps to handle a 30-degree Baumé solution of zinc sulphate containing some cadmium, copper, and nickel compounds, among other impurities. The pumps are bronze-fitted, but the bronze fails rapidly, becoming porous, pitted, and brittle. This trouble is noticed especially on the valve stems and seats. Can readers suggest some other alloy that would give better service here? It is necessary to avoid contamination by iron. We attribute the difficulty to substitutions brought about by the



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CUTS *maintenance* COSTS

Pyroil is the latest scientific achievement in lubrication. Simply *added* by the ounce to the regular oil and grease, it cuts friction, overheating, wear and damage because it sheaths all frictional metal with a heat-proof, wear-resisting surface of protection, which constantly renews itself. Actually *makes metal self-lubricating.* Cuts operation costs.

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All Metals—and in Celoron, Micarta, Formica, Fabroil, Rawhide and Textolite.

Silent, smooth-running gears. Promptest kind of service on urgent replacement jobs.

Let us quote.

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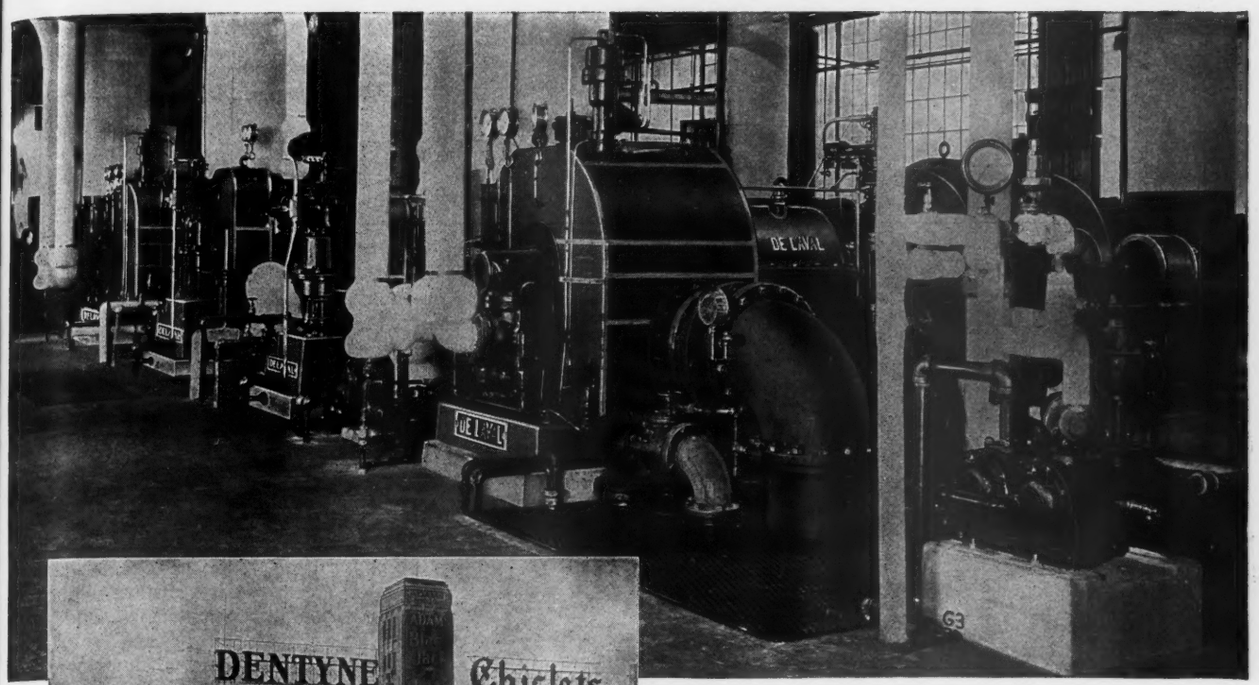


$0.00607 per Kw/Hr

BY utilizing exhaust and bled steam in the process and for heating and by installing a cooling tower so that one turbine can be run condensing when additional power is required, the Long Island City plant of the American Chicle Company was able during the month of December to produce current at a cash cost of $0.0067 per kw/hr., which includes fuel, water, oil, labor, repairs, insurance, and a small amount of current purchased for emergency lighting. While this figure does not provide for interest and depreciation, the results of operation from May 15, 1933 to February 28, 1934, indicate that the savings in cost of power and water will repay the total investment in about four years.

The new power equipment comprises the following:

FOUR DE LAVAL GEARED TURBINES:

A condensing extraction turbine arranged for bleeding 6000 lb. per hr. at 35 lb. gage and driving a 375 kw. alternator,
A non-condensing extraction turbine driving a 375 kw. alternator,
A straight non-condensing unit of 230 kw., and
A non-condensing night machine of 140 kw.

A leaflet, Publication A. C., which will be sent upon request, gives full particulars and may prove useful in studying how most profitably to modernize your own plant.

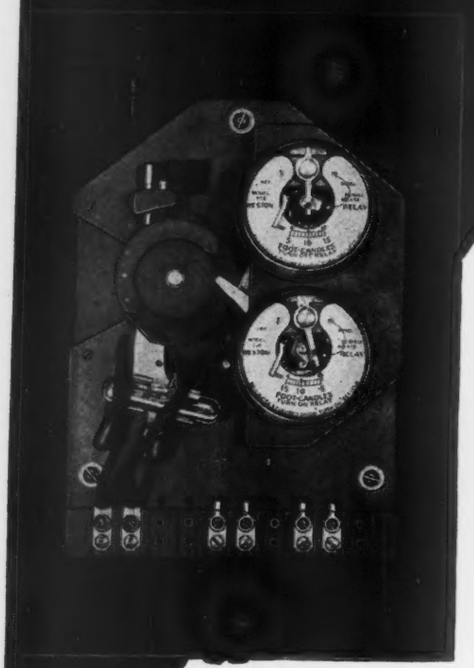
De Laval *Steam Turbine Co.*, Trenton, N.J.

3165

Manufacturers of Steam Turbines, Centrifugal Pumps, Propeller Pumps, Rotary Displacement Pumps, Centrifugal Blowers and Compressors, Worm Gears, Helical Speed Reducing Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery. Sole Licensee of the Bauer-Wach Exhaust Turbine System.

Now A PRACTICAL INDOOR *lighting control relay*

-TURNS LIGHTS ON WHEN NEEDED
-TURNS THEM OFF WHEN NOT NEEDED



POINTS OF INTEREST TO YOU

1. Light intensity "on" 5 foot-candles up.
2. Light intensity "off" 5 foot-candles up.
3. Energy consumed operating — 2 watts for 1 minute.
4. Energy consumed not operating—0.
5. Employs life-time, self-generating Photronic Cell.
6. Cell operates sensitive relays direct—no outside voltage—no amplification.
7. Sensitive Relays operate main circuit direct by small clock motor—no auxiliary relays.
8. Cell can be mounted anywhere desired.
9. Indicating Relay gives constant indication of light intensity in room.
10. Installation simple—maintenance low

Now you can have an automatic, silent sentinel in complete control of your plant lighting . . . and save money doing it. Save it through the greater efficiency which results from always having the proper light when light is needed . . . save it by not having lights burning when artificial lighting is not necessary.

The new WESTON Model 709 automatically turns lights on, and turns them off, at any light levels you desire. The Relay Cabinet is quickly connected to the lighting circuit, and the light target placed wherever needed. The Indicators then are set for the light values at which lights are to be turned on and off. That's all there is to it. From then on, operation is automatic, and dependable.

Read all the advantages of Model 709, listed above. Then send for full particulars on this inexpensive, fool-proof Lighting Control to-day . . . Weston Electrical Instrument Corporation, 628 Frelinghuysen Avenue, Newark, New Jersey.

NRA

WESTON *Instruments*

positions of the metals mentioned above, in the electrochemical series. Are we correct in making this assumption? *D.D.—Chicago*

THERE are several alloys that may be considered. One is the well-known 18-8 alloy containing: chromium, 16-20 per cent; nickel, 7-10 per cent; carbon, 0.05-0.15 per cent; manganese, 0.30-0.50 per cent; silicon, 0.50 per cent, maximum. It is resistant to zinc sulphate and chloride, aluminum sulphate, copper sulphate, and many other compounds. This alloy can be obtained in the form of castings, forgings, tubes, and plates and has been used for handling hot sulphite liquor in paper making; also, in soap making and in oil refining.

Also to be considered is an iron alloy containing: chromium, 3.23 per cent; nickel, 13.63 per cent; copper, 6.48 per cent; carbon, 3.04 per cent; silicon, 1.64 per cent. It is resistant to the action of sulphates, chlorides, and such acids as hydrochloric and sulphuric. Castings of this material, known in the trade as Ni-resist, have been made for hot oil pumps, oil condensers in refineries, hot sections of glass annealing furnaces, and other purposes.

Possibly the design of the pump or other parts of the installation with which zinc sulphate causes trouble could be modified so that some phenol compound or rubber could be used. These materials are resistant to many agents, but if rubber is used care must be taken to see that the temperature does not exceed about 150 deg. F.; otherwise, the rubber will become soft.

CHARLES H. HUGHES
New Dorp, S. I., N. Y.

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Trade Literature

(Continued from editorial page 478)

application of product to a given use.—Dow Chemical Co., Midland, Mich.

CLUTCH—Bulletin 36, "The Conway Compression Clutch."—The Conway Clutch Co., Cincinnati.

CONVEYOR CHAINS — Catalog V-116, "Whitney Conveyor Chains."—The Whitney Mfg. Co., Hartford, Conn.

DRAFTING EQUIPMENT — "The Bruning Perspective" Vol. 1, No. 4, and "Black and

EVERY DOLLAR SAVED *in Steam Cost* ADDS A DOLLAR TO NET PROFITS

A saving of 5% on your fuel bill is equal to the net profit on how much new business?

The day is rapidly approaching when no man will operate a boiler plant unless it is equipped with the means whereby its daily performance may be checked and its operation closely controlled.

In generating stations, the cost per unit of electricity fluctuates as the boiler house efficiency, while the cost of steam in industry has a far-reaching effect upon net profits.

Control cannot be effective unless based upon truth-telling instruments which give reliable guidance to operators at the operating platform —and provide essential records at a convenient point for the engineer in charge of plant operation.

When you decide—as you eventually will—to take full advantage of the assistance modern instruments can render, a statement of your problem to Republic will make available an unmatched engineering service. Our engineers will be glad to study your problem and make recommendations which will be of practical aid in reducing the cost of steam in your plant.

WRITE FOR BULLETIN "REPUBLIC ECONOMY IN INDUSTRY"

REPUBLIC FLOW METERS CO.

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ARMORED KATHANODE BATTERIES

POWER INDUSTRIAL TRUCKS longer and at lower cost

GOULD Armored Kathanode batteries reduce initial and subsequent operating costs to a minimum, because the required investment is least for batteries which deliver longer, efficient and reliable service.

Longest operating life is obtained from the active material of the positive plates due to the protection afforded by the glass mat retainers and the extraordinary, rugged mechanical construction.

The high operating efficiency of Armored Kathanode batteries is shown by their ability to recharge rapidly, requiring a minimum of overcharge, and distributing this energy at the same rate of discharge over a longer working day than other types of batteries. Further, Gould Kathanode Batteries are sold under a definite guarantee, providing an established monthly investment cost. Write for Bulletin No. 946.

Gould Armored Kathanode Battery installed in the battery compartment of an Industrial Truck.

GOULD
STORAGE BATTERY CORPORATION
OF DEPEW, NEW YORK
GENERAL OFFICES AND FACTORY, DEPEW, N.Y.
Sales Offices in the Principal Cities of the U. S. A.

White Magic."—Charles Bruning Co., Inc., 102 Reade St., New York.

DRIVE—Folder 1460, illustrates, describes Link-Belt $\frac{3}{16}$-in. pitch silent chain drives.—Link-Belt Co., 910 S. Michigan Ave., Chicago.

ELECTRIC HEATING UNITS — Leaflet TB30, pages 7 and 8, on heating oil with Trent electric immersion units.—Harold E. Trent Co., 618 N. 54th St., Philadelphia.

ELECTRIC PRODUCTS—Catalog 34, "Bull Dog Electric Products."—Bull Dog Electric Products Co., Detroit.

FIRE BRICK—Bulletin, "A. P. Green Presents G-25, a Controlled Insulating Fire Brick."—A. P. Green Fire Brick Co., Mexico, Mo.

FURNACE—Bulletin GEA-1924, on controlled-atmosphere electric furnaces and their auxiliaries.—General Electric Co., Schenectady, N. Y.

FURNACE—Catalog No. 349, on continuous controlled atmosphere furnaces.—W. S. Rockwell Co., 50 Church St., New York.

GAGES—Bulletin WG-1803, on water level gages and water column alarms.—Yarnall-Waring Co., Chestnut Hill, Philadelphia.

GEARS—Catalog, gears. pinions, speed reducers, hoists, valve operators.—Philadelphia Gear Works, Erie Ave. and G St., Philadelphia.

HARD-FACING — Bulletin, "Hard-Facing with Haynes Stellite Products." Second edition, revised.—Haynes Stellite Co., Kokomo, Ind.

IRON — Two pamphlets, "Facts You Should Know About Armco Enameling Iron," and "How Porcelain Enamel Can Help You Sell More Profitably."—American Rolling Mill Co., Middletown, Ohio.

IRON—Bulletin No. ADV.132, "Thumbs Down on Rust," concerns rust-resistance of Toncan iron.—Republic Steel Corp., Massillon, Ohio.

LUBRICATION—Form 33, "Gulf's 7-Point Plan for Industrial Lubrication."—Gulf Refining Co., Pittsburgh.

LUBRICATION—Form No. 247, "Suggestions for Lubrication Cost Recording."—Gulf Refining Co., Pittsburgh.

MATERIAL HANDLING—Book, "The Fiftieth Year," commemorating the golden anniversary of the company.—Harnischfeger Corp., Milwaukee.

METERS — Five bulletins, M975-B12, M975-B13, M975-B14, M975-B15, and M975-B16, describing types of disk water meters.—Worthington-Gamon Meter Co., Harrison, N. J.

MOTOR REDUCER—Bulletin No. 272, on Faulk Motoreducers, superseding Bulletin No. 270.—The Faulk Corp., Milwaukee.

MOTORS—Bulletin describing improved development of geared reductions in electric motors.—U. S. Electrical Mfg. Co., 1510 S. Western Ave., Chicago.

MOTORS—Bulletin No. 516, on advantages and economies of shaftless motors.—The Louis Allis Co., Milwaukee.

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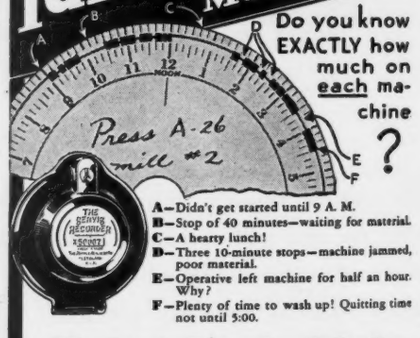
Idle Time of Machinery!



Do you know EXACTLY how much on each machine ?

A—Didn't get started until 9 A. M.
B—Stop of 40 minutes—waiting for material.
C—A hearty lunch!
D—Three 10-minute stops—machine jammed, poor material.
E—Operative left machine for half an hour. Why?
F—Plenty of time to wash up! Quitting time not until 5:00.

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See how "time down" stands out on the chart above. You can't miss it. You can't help but reduce it!

Suppose you could reduce idle time on all your factory machinery nearly 10 minutes a day! What would it amount to in a year—or even a month! More than you'll ever save by "little economies."

This little "time clock for machinery," the *Servis Recorder,* bolts or clamps right on to the machine itself—no ink, no pencils, no electric wires. Send for folder, "A Busy Plant."

THE SERVICE RECORDER COMPANY
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THE SERVIS RECORDER
The "Time Clock" for Machinery

SPECIAL-PURPOSE A-C MOTORS

NEW GROUPS BRING LOWER FIRST COSTS . . . SIMPLIFIED CONTROL, AND REDUCED MAINTENANCE.

This enclosed, fan-cooled, squirrel-cage Reliance Motor is used in steel mills for the conveyor drive on automatic rolling and catching tables. These motors will withstand up to 40 reversals a minute without excessive temperature rise. Low-inertia rotors are used to keep reversing losses at a minimum.

✦ ✦ ✦

FIELDS of application, usually thought of as belonging strictly to direct-current or slip-ring motors, are being invaded by the squirrel-cage induction motor. Developments by Reliance Engineers have removed some of the limitations commonly associated with the squirrel-cage motor and have opened the way to a more universal use.

HERE'S AN EXAMPLE . .

The motor shown below operates the edger adjustments for one of the stands of a continuous strip mill. Customary practice calls for a d.c. mill-type motor to provide the necessary torque and quick reversing. The job is being handled with satisfaction by a Form OH squirrel-cage Reliance Motor designed with the desired torque and inertia characteristics. The first cost with control was only 33% of the d.c. equipment.

Other applications in connection with this same mill are loopers, side guides, and draw backs. The same percentage of savings applied.

HERE ARE 3 BULLETINS . .

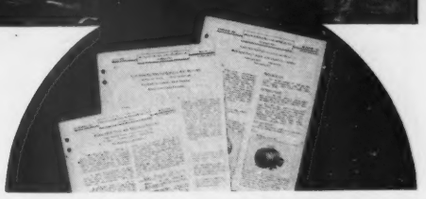
Here are three brief bulletins designed to indicate how some of these special-purpose motors may fit in with some of your work:

No. 114 Low-inertia, Special-torque A.C. Motors. For quick acceleration, quick stopping, frequent and rapid reversing.

No. 115 High-starting Torque, Low-starting-current Motors. For loads which offer considerable resistance at starting, but require a decreased torque at full load.

No. 116 A.C. Motors for Flywheel Applications.

These bulletins don't tell the whole story because we don't know the end ourselves. If you will tell us of any special jobs, however, we shall be glad to work with you without obligation on your part. The chances are favorable that we can develop something which will save you money or improve operating results.



RELIANCE A-C D-C MOTORS

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Ivanhoe Road Cleveland, O.

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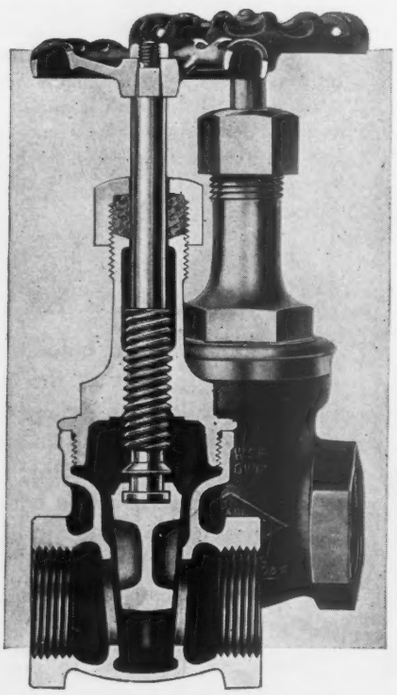

New Traveling Spindle Valves Offered for Various Pressures

Now, when you want Bronze Gate Valves with a Traveling Spindle you can specify "Jenkins". New additions to the Jenkins line include this type of Gate, with both screwed and flanged ends, for various working pressures. Fig. Nos. 47 and 48 are for 125 lbs. steam or 200 lbs. Oil, Water, Gas. Fig. Nos. 49 and 50 handle 150 lbs. steam or 225 lbs. Oil, Water, Gas.

These new Gates fully conform to Jenkins' standards and have many fine features which assure long and satisfactory service. All bonnet threads are in contact with the spindle *at all times*. An extra large stuffing box holds more packing. A double-faced solid wedge and precision machined seating surfaces assure tight closure. Wedge is entirely out of the line of flow when valve is fully open.

You can meet practically any need from the complete Jenkins Bronze Gate Line —Data on recent additions to the line will be found in a supplement to the Jenkins No. 23 Catalog which will soon be ready for distribution. Write for it to be sure that your name is on our list.

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Jenkins Valves

BRONZE—IRON—STEEL SINCE 1864

PACKINGS—Bulletin, "Authentic Information on Hydraulic Packings that is Not in Any Text Book."—Chicago Belting Co., 125 N. Green St., Chicago.

PUMPS—Bulletin No. 50-B11, concerns new high-duty Connersville vacuum pumps. —Roots-Connersville Blower Corp., Connersville, Ind.

PUMPS — Three bulletins, W-101-B2, W-312-B3, and W-318-B5, on horizontal duplex piston, single-stage volute centrifugal, and two-stage volute centrifugal pumps respectively.—Worthington Pump & Machinery Corp., Harrison, N. J.

REGULATOR—Catalog 10-A, "Kathetron Manual Regulator for Alternating Current Only."—Roller-Smith Co., 233 Broadway, New York.

REGULATORS—Catalog No. S-10, data covering application, principle of operation, and construction of Smoot regulators.—Smoot Engineering Corp., 2240 Diversey Parkway, Chicago.

SPRINKLER SUPERVISOR—Bulletin No. 60, "Prevent Costly Sprinkler Freeze-ups with the New Rockwood Dry Pipe Supervisor."—Rockwood Sprinkler Co., Worcester, Mass.

STEEL—Catalog, "Machinery Steels."—Crucible Steel Co. of America, 405 Lexington Ave., New York.

SWITCHES—Form No. G 334, "Thousands of Cleveland Tramrail Switches in Service."—The Cleveland Crane & Engineering Co., Wickliffe, Ohio.

TEST PROBE—Folder, "New Duplex Test Probe."—Electric Service Supplies Co., 17th and Cambria Sts., Philadelphia.

TURBINES — Bulletins S-80 and S-84 illustrating and explaining application, construction, superiority of Terry Wheel Turbine.—The Terry Steam Turbine Co., Hartford, Conn.

UNION—Bulletin, on an "improved" Rockwood union with two silicon bronze seats.—Rockwood Sprinkler Co., Worcester, Mass.

V-BELT—Catalog JS-215, covering belts for both multiple-groove and fractional-horsepower drives.—L. H. Gilmer Co., Tacony, Philadelphia.

VALVE—Bulletin No. 1, "The Hoppe Electro-Hydraulic Valve."—A. F. Hoppe Engineering Co., Indianapolis.

VALVES—Folder, "Introducing a Compact Relief Valve for Industrial Use."—Tuthill Pump Co., 131 W. 63rd St., Chicago.

WATERPROOFING — Bulletin A.I.A. File No. 7-B-21, "The Forgotten Structure," describes the Cement-hide waterproofing system.—Pittsburgh Plate Glass Co., 2200 Grant Building, Pittsburgh.

WELDER — Bulletin No. 303, "General Specifications for Belted or Direct-Driven Types SA300, SA400, and SA600 Shield Arc Welders."—The Lincoln Electric Co., Cleveland.

WELDED PARTS—Bulletin M13, "Struthers-Weld Certified Machine Parts of All Commercial Metals." — Struthers-Wells Co., Warren, Pa.

This booklet should be on every MAINTENANCE MAN'S desk

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IS THE MOST PRACTICAL MATERIAL TO REPAIR FLOORS LIKE THESE

It permanently fills and smooths shallow as well as deep ruts, holes and breaks in every type of industrial floor and platform. No chipping or chopping of the old surface. No heating of materials.

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Free - 16 page Booklet ****describing practical methods for repairing and resurfacing rutted, broken and irregularly worn factory floors and platforms without interrupting production.

It tells how any handy man can permanently stop water leaking through walls, whether it be an occasional seepage, or a stream the size of your fist; methods for resurfacing and renewing thin, weather-beaten roof surfaces; how to rustproof outside metal work, fire escapes, fences, tanks, etc.; how to repair spalled building walls, acidproof and waterproof floors, in fact it gives the solution to practically every maintenance problem around a plant.

This booklet is proving of invaluable assistance to maintenance men everywhere. If you do not have your copy of "Over the Rough Spots" write today—IT IS FREE—if your request is made on your company letter-head.

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Have you ever stopped to consider the *real worth* of a Stewart Fence? Factories, storage yards, manufacturing plants of all types are being Fenced nowadays—because the proper Fencing is a positive protection against vandals, thieves and intruders. Fence stands as a loyal watchman, 24 hours a day—and yet the initial cost of a Stewart Fence is small compared with the security it offers. Stewart Chain Link Wire Fence is recognized for its stability, its structural advantages and its unsurpassed quality. There is a Stewart sales and erection office near you to help you plan and figure your Fencing job. Write us at your convenience—we'll put you in touch with that service office of ours. No obligation!

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Perfect Atomization
at
LOW AIR PRESSURES
IMPERIAL
TRY THIS TEST
Make an actual test of the Imperial spray gun in comparison with any other make. You will find the Imperial gives better performance at every point—ease of operation, speed and simplicity in cleaning, and quality of work on completion.

THE low cost of operating the Imperial Paint Spray gun is partly due to the special design of the spray head, which maintains unimpaired quality in the work even at low pressures. The flow is perfectly steady, with complete atomization, uniform covering, and perfect finish. Also, the light weight construction and perfect balance enable the operator to work longer and more efficiently.

Order from your jobber

THE IMPERIAL BRASS MFG. CO.
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BOOKS

INDUSTRIAL MARKETING

John H. Frederick, Assistant Professor of Commerce and Transportation, Wharton School of Finance and Commerce, University of Pennsylvania. Prentice-Hall, Inc., 70 Fifth Ave., New York. 401 pages, index, bibliography. $3.50.

Covers the various aspects of marketing, including market analysis, trade channels and middlemen, personal salesmanship and advertising, policy, marketing costs, trade associations. Considers only manufactured or semi-manufactured goods. Takes account of NIRA and its effect on the subjects mentioned.

ELECTRON TUBES IN INDUSTRY

Keith Henney, Associate Editor, *Electronics*. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York. 490 pages, illustrated, index. $5.

Since, less than five years ago, industry began to turn electron tubes to varied noncommunication uses, much has been written disconnectedly about how, when, where, and why to use them in manufacturing. The author presents for the first time under one cover a complete exposition of the subject for the enlightenment of industrial engineers.

EXECUTIVE ABILITY

Its Discovery and Development

Glen U. Cleeton, Professor of Psychology and Education, Head of the Department of Industrial Education, Carnegie Institute of Technology, and Charles W. Mason, Readers Counselor, Carnegie Library of Pittsburgh. The Antioch Press, Yellow Springs, Ohio. 183 pages, appendix, index. $2.

For executives, those who aspire to be executives, and those who must select and train men for executive positions.

MECHANICAL CATALOG 1934-35

The American Society of Mechanical Engineers, 29 West 39th St., New York.

An index to manufacturers of industrial equipment, materials, and supplies. Includes an Index to Catalogs, Catalogs of Advertisers, Index to Manufacturers.

On the Calendar

OCTOBER

22-26, American Foundrymen's Association, 38th annual convention, and Fifth International Foundry Congress, Philadelphia. C. E. Hoyt, Secretary, 222 W. Adams St., Chicago.

DECEMBER

3-8, Eleventh National Exposition of Power and Mechanical Engineering, New York. Charles F. Roth, International Exposition Co., Manager, Grand Central Palace, New York.

3-8, American Society of Mechanical Engineers, 56th annual meeting, New York. Calvin W. Rice, Secretary, 29 W. 39th St., New York.

Boilers

1 During comparable periods in 1933 and 1934 the Russell-Miller Milling Company, Minneapolis, burned 2352 and 1681 tons of coal, respectively. The saving, approximately 29 per cent, is attributed to modernized boiler room equipment. Two new 125-hp. horizontal return tubular boilers with unit pulverizers were installed.

2 Jacob E. Decker & Sons, Mason City, Iowa, packers, have a new high-pressure, high-temperature steam plant that supplies all the necessary steam for power and heat. Equipment includes two 484-hp. boilers with interdeck superheaters furnishing steam at 450 lb. pressure and 191 deg. F. superheat, and air preheaters that furnish preheated combustion air at 375 deg. F. During the first 249 days of operation, the new plant showed a gross saving of $49,073.27 over previous charges for steam and electricity.

3 More than $33,000 a year represents the savings to a manufacturer of leather cloth and lacquers through the replacement of four return-tubular and two old oil-fired, water-tube boilers by two modern steam-generating units burning anthracite barley on traveling-grate stokers.

4 A large Chicago packer installed three modern boilers with coal pulverizers, economizers, air heaters, and three turbine units exhausting to process, is saving at the rate of over $100,000 a year compared with the old low-pressure installation.

5 Approximately $1,000 per month is being saved by a small oil refinery in Pennsylvania through burning $1.75 instead of $2.50 coal. Four boilers fired with an obsolete type of natural draft stoker comprised the old boiler plant. Two of these units were replaced by a modern 500-hp. boiler fired by a single-retort underfeed stoker using forced draft. The new unit operates regularly at over 200 per cent rating and carries the entire plant load.

6 One 750-hp. boiler replaced six boilers totaling 2,200 horsepower at J. L. Stifel & Sons, Inc., Wheeling, W. Va. This plant is a textile dyeing establishment, uses a great deal of steam. The first year 10 per cent more steam was produced, yet steam cost was reduced $23,700. Some of the saving was due to operating one boiler instead of six and reducing the amount of boiler-room labor. Much of it was due to the increased efficiency of the new unit and its ability to carry high continuous ratings with very little maintenance to the stoker, none at all to boiler and furnace.

7 Annual power savings at the American Thread Company, Willimantic, Conn., total $41,000, just 31 per cent of former operating cost, 40 per cent of the investment in new equipment. Eighteen old boilers were replaced with three modern 657-hp. boilers fired with powdered coal.

8 A cement plant in Eastern Pennsylvania installed two 740-hp. waste heat, water tube boilers, each equipped with vertical economizers to utilize the heat from the kilns. Each economizer has a heating surface of 2,500 sq. ft. Results: Average increase in feed water temperature, 90 deg. F.; enough B.t.u's added to feed water in 24 hours to equal 6.23 tons of coal. Gross savings per day, $31.15; total cost per day, $22.67; net saving, $8.48 a day. The plant operates 358 days a year, so annual saving is $3,035.84. That's $0.00269 net profit per barrel of cement.

9 A Chicago concern installed a stoker with a feeding capacity of 1,200 lb. per hour, now burns at high efficiency a size of coal that costs $2.70 a ton less than the grade required when the boiler was hand-fired. The boiler-room saving on ash handling amounts to about $80 a month. The chief engineer estimates that the equipment actually paid for itself in six months' time.

10 Four hand-fired boilers at Olson Rug Company, Chicago, consumed from 3,500 to 4,000 tons of Pocahontas Coal costing $5.15 a ton. As time progressed, the plant load was increased 20 per cent. Instead of adding boiler equipment, automatic stokers were installed. Indiana screenings costing $3.15 a ton is now being burned with perfect satisfaction, and the amount of coal used has been reduced to about 3,000 tons a year. The plant is located in a semi-residential neighborhood, so the practical elimination of the smoke nuisance is an important by-product of the new installation. Coal is delivered in bottom-dump cars which empty into a track hopper. A chain-driven belt conveyor carries the fuel into a 200-ton overhead bin, whence it is conveyed to the stoker hoppers via traveling bucket and electric hoist. The bucket is of 750-lb. capacity—just big enough to fill a stoker hopper.

Stokers

11 The Waukesha Motor Company, Waukesha, Wis., installed stokers under three of the six hand-fired boilers required to carry the load. During the first three months of operation savings in coal and labor were $2,714, or 31 per cent. Stokers increased the capacity of the boilers so much that the entire steam load can be carried by the three stoker-fired units.

12 Less than two heating seasons sufficed to pay for a stoker [illegible] of savings at the plant of the American

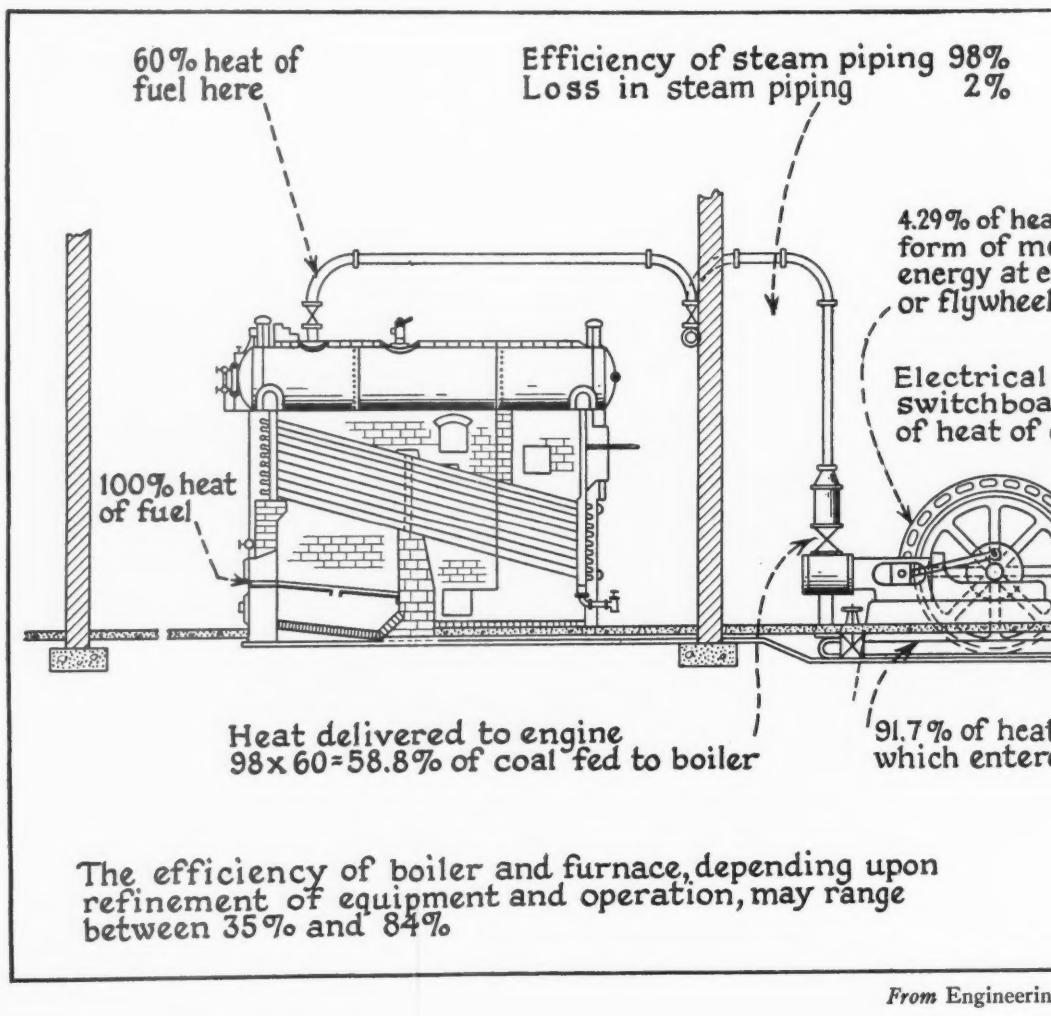
Oil Burners

21 A 40 per cent annual saving in the cost of heating the plant of M. L. Bayard & Company, Inc., Philadelphia, resulted from the replacement of coal with oil fuel. Labor and fuel costs, with coal firing, amounted to nearly $2,100 a year; the total cost, labor and all, for oil firing is about $1,245, giving an average saving of $833 a year.

22 A wallpaper factory in Southern Pennsylvania used to burn 10 tons of coal a day at $4.50 a ton. Steam-atomizing oil burners, complete with preheaters, air cushions, pump sets, automatic cut-off valves, strainers, etc., showed a $1,000 saving the first year in fuel cost. Increased steam capacity, moreover, enabled this concern to turn out 7,000,000 rolls of wallpaper against 5,000,000—a 40 per cent increase.

23 Manually operated steam-atomizing oil burners, installed by a large steel company that burns 40,000,000 gallons of fuel oil a year, are saving 7 gallons of oil on every ton of steel.

24 Changing from coal to oil fuel enabled the Lyons Piece Dye Works, Paterson, N. J., to cut steam costs about $61,000 a year. That saving represents a return of 109 per cent on the initial investment of $56,000. Steam is generated at 100 pounds per square inch pressure. Cost of coal was just short of $200,000 a year, with an annual consumption of about 43,000 tons. Following the change to oil fuel, boiler-room labor and expense was reduced from $47,000 to $19,000, cost of fuel was reduced from $200,000 to $166,000, over-all efficiency rose from 64.07 per cent with coal to 79.6 per cent with oil, and cost per thousand pounds of steam fell from 30 cents with coal to 19.13 cents with oil.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From Engineerin

25 Savings of $5,000 a year in maintenance and labor costs followed the installation of oil-burning equipment in the boiler plant of Conde Nast Press, Greenwich, Conn. There has likewise been a considerable saving in the cost of fuel but the amount cannot be figured accurately because of additions to the plant and changes in the load.

Meters

26 Sullivan Machine Company, Claremont, N. H., installed two boiler meters. Fuel consumption since then has been 10 per cent less. Savings the first year amounted to more than twice the initial investment.

27 A boiler meter provided Schaffner Bros. Co., packers of Erie, Pa., with accurate data for fuel selection. This concern purchased a number of grades of coal of different prices and varying freight rates, used the meter to check boiler output, found it got more steam for its coal dollar by buying a more expensive coal with a lower freight rate. The flue gas temperature recorder of the boiler meter serves as a guide to soot blowing.

28 An Eastern concern installed boiler meters on four 254-hp. hand-fired boilers that used a mixture of anthracite screenings and bituminous coal. After a short time the meter supplied information which caused the company to change the ratio of anthracite to bituminous. A saving of $1,000 a month returns the cost of the meters four times annually.

29 Five boiler meters are credited by Spalding Fibre Company, Tonawanda, N. Y., with gross savings of $500 a month in its stoker-fired steam plant. Actual tests with and without these guides to economical combustion showed a 10 per cent saving when the firemen kept their eyes on the air-flow

IOW 114 PLANTS MADE

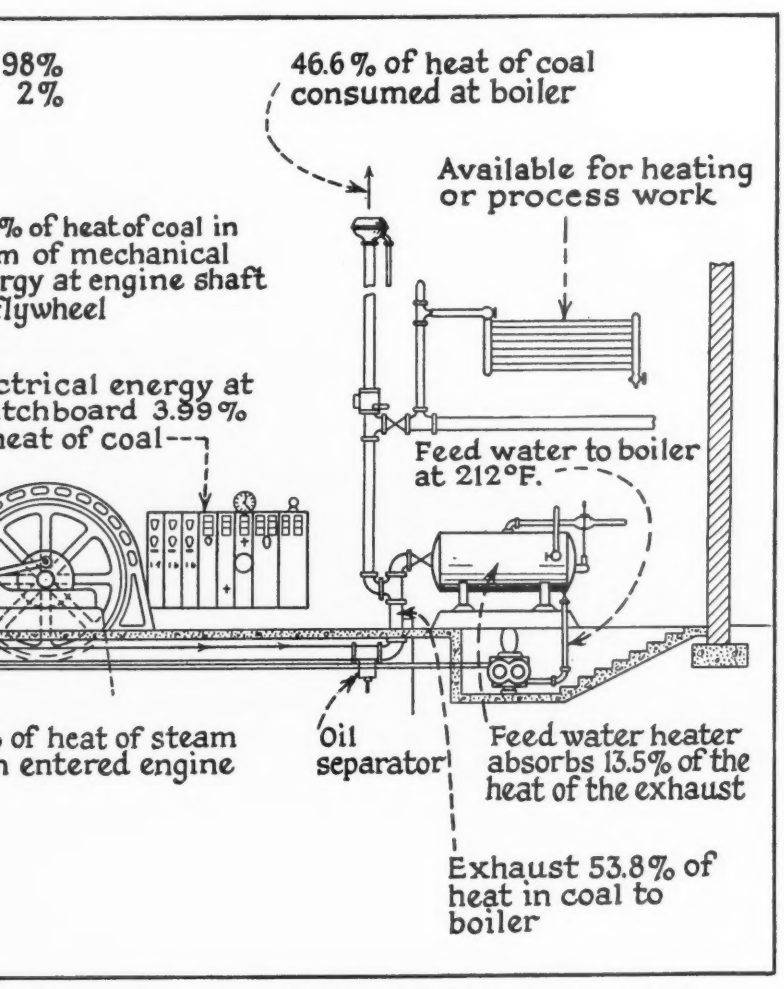
38 Old power plant equipment at the North Carolina Finishing Company was replaced with a turbine that provides power and process steam. Cost was $19,200 including engineering. Including cost of labor for operating the turbine and a generous allowance for depreciation, the saving is at the rate of $13,500 annually—70 per cent of initial investment.

39 Money is no longer exhausted to atmosphere in the shape of waste steam in a certain New England department store's power plant. Steam, from its reciprocating engines is now utilized in a mechanical-drive turbine, saving $3,761 a year.

40 By coupling turbines to motor-generator sets the Oregon Pulp & Paper Company, Salem, Oregon, found it could better supply the demand for drying steam on four paper machines. The new equipment paid for itself in ten months; the continuing annual savings of $18,000 now add to net profits.

41 About $30,000 worth of exhaust steam that had passed through reciprocating engines used to be wasted annually in the power plant of Runkel Brothers, Inc., New York. This loss was stopped by the installation of a 750-kw., mixed-pressure turbine. Some high-pressure steam is mixed with the engine exhaust and in passing through the turbine produces 460 kw. of electrical energy. The annual saving amounts to about half the cost of the installation.

42 Desire to obtain power at a lower cost than was possible with their old steam plant led the Commander Milling Company, Minneapolis, to install three 800-hp. diesel-electric units and motor drives. On the basis of purchased power at 1.1 cents a kilowatt-hour, the savings have ranged from $24,000 to $29,000 a year.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Engineering of Power Plants *by Robert H. Fernald and George A. Orrok*

43 The Sears-Roebuck Retail Store in Camden, N. J., paid $11,724.80 for power in 1932—an average of 3.48 cents per kilowatt-hour. Two diesel engine generating units with a rated capacity of 90 kw. each at 80 per cent power factor took over the store load in December, 1933. In the ensuing period from December 13, 1933 to April 23, 1934 the new equipment had generated 91,600 kw.-hr. with 8,654 gallons of fuel oil at 5 cents a gallon and 253 gallons of lubricating oil at 40 cents—a total fuel and lubricating cost of $533.90. Miscellaneous expense equalled $3.40. Total operating cost was, therefore, $537.30 or 0.587 cent per kilowatt-hour. No labor was included in this statement, because no additional labor was needed.

44 It used to cost $510 a year to drive three chain grate stokers in the Hoover Company's plant, North Canton, Ohio. A steam engine installed adjacent to the boilers and direct connected to the stokers brought that figure down to $167 a year. Net annual savings, $343. Annual return on investment, 67 per cent.

45 Byproduct power saves Moulding-Brownell Corporation $765 a year. Three 150-hp. boilers supply steam. A 30-kw. d. c. generating set receives saturated steam at 115 lb. pressure, generates 68,000 kw.-hr. annually, and returns the exhaust to steam-heating coils in a kiln where molded blocks are dried preparatory to firing. The low maintained steam rate of this generating set is responsible for proper heat balance and low power cost—slightly over ½ cent per kw.-hr. compared with the local utility rate of 1.7 cents at the time the installation was made.

46 An old steam plant in the mill of the Wm. E. Hooper & Sons Company, Baltimore, was replaced by two 950-horsepower diesel engines direct-connected to generators. Savings over previous power costs are in the neighborhood of

53 Operating a. c. motors with an aggregate rating of 200 hp., a paper mill was able to raise the plant power factor from 57 per cent to 90 per cent by the installation of a 50-hp. synchronous-type induction motor, driving a calender stack. Improvement in power factor and reduction in demand charge have resulted in an average saving of $816 annually.

54 A large baking company in the East had been paying $1,560 a year in penalties because of 70 per cent power factor, until a 60-kva. capacitor was installed to raise the power factor of the 140-kw. load to 90 per cent. Rearranging a few motors to secure proper loading further raised the power factor to around 99 per cent, where it is now maintained. The elimination in penalty charges paid for the installation in about fourteen months.

55 In a plant in which fruit is wrapped for the market, a change from induction to synchronous motors resulted in improvement in efficiency and power factor. A study of costs after seven months of operation indicated an annual saving of $3,800. Of this amount $2,600 was the saving due to power factor improvement and $1,200 resulted from greater efficiency, and increased output due to constant speed. With an investment cost of $11,700, the savings represent a return of 32 per cent.

56 A 240-kva. capacitor installed at a cost of $3,000 in a Western oil refinery raised the over-all power factor from 62 per cent to 95 per cent. Consequent improvement in line conditions has made possible an annual saving in power amounting to the cost of the corrective equipment.

Bearings

57 In a metal-working shop ball bearings were installed in place of plain bearings on the lineshafts from which a battery of automatic screw machines are driven. Comparison of past and present performance records shows a reduction in power requirements which has cut power bills about $225 a year, with a saving in maintenance and lubrication costs that amounts to more than $46, or a total saving of about $271 a year. At this figure the return on the investment is 45 per cent.

58 Four babbitted bearings on a lineshaft from which two white lead mixing tanks are driven, in the plant of an Eastern manufacturer of paint pigments, were replaced with roller bearings. After installation it was determined that the average power load had dropped from 23.9 hp. to 17.85 hp., a difference of 6.05 hp. Saving in power costs is $230 a year, which has been increased to $238 a year through reduction in lubrication costs. Installation cost of the roller bearings was $254, which includes all fixed charges; hence, the installation returns 95 per cent of its cost annually.

59 As part of an economy program in cutting costs by reducing power requirements a Middle-Western flour mill replaced with roller bearings the babbitted bearings in the roll journals and tunnel shaft of a double roller mill. The average power input to the mill when using the plain bearings was 8.57 hp.; when fitted with roller bearings the power input dropped to 5.86 hp., representing a saving of 2.71 hp., or 31.8 per cent. Incidental advantages are a considerable reduction in grinding temperature, with elimination of tramming, rebabbitting of bearings and replacement of roll journals, and reduction in frequency of lubrication from once every eight hours to once in three months.

60 An Eastern knitting mill replaced fifteen babbitted hanger bearings supporting a 60-ft. lineshaft with roller bearings. This shaft drives 24 knitting machines. Average power requirements with the old bearings were 16.40 hp. After installation of roller bearings the load on the motor dropped to 13.40 hp., a saving of 3 hp. At a power cost of 2 cents a kilowatt-hour the saving in energy consumption amounts to $120.84 a year. Reduction in the amount of lubricants used and the labor for applying them brought total savings up to somewhat more than $150 a year. Installation costs were about $192, giving a return of 78 per cent on the investment.

61 A large foundry installed 27 ball bearings in the tumbling barrels, replacing the plain, sleeve type. The reduction in power consumption, oil, and labor required for lubrication are estimated at $523, annually. This is 98 per cent of the installation cost.

62 In a Southern textile mill ball-bearing pillow blocks were installed on four spinning frames, replacing the plain bearings originally employed. Installation cost of the new bearings was $250. Power requirements were reduced so much that the savings in this item, together with the reduction in lubricant and labor costs are estimated at $262 a year. Annual return on the investment is 105 per cent.

63 A manufacturer of laundry machinery was able to save more than $200 a month by using self-lubricating bearings in the pulleys of these machines. The pulleys are located in an out-of-the-way place where they are likely to be neglected. Under his guaranty the manufacturer was obligated to install new shafts, pulleys, and bearings when failure occurred. Self-lubricating bearings have eliminated such cases.

64 Ball bearings were installed on three lineshafts, each approximately 80 ft. long, from which 20 cigarette machines are driven in a Southern tobacco factory. Power load with the shafts running in babbitted bearings was 40.13 hp., on

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MADE POWER SAVINGS

69 An example of how a reduction in the viscosity of oil will lead to power economy was recently observed in the lubrication of spinning frames in a textile mill. On these machines the use of an oil having a viscosity of 60 seconds Saybolt at 100 deg. F., in place of an oil having 100 seconds viscosity, showed a reduction in power requirements of approximately 4.8 watts a spindle. Such a saving mounts to a considerable reduction in power consumption in a large mill.

70 With the roll-neck grease formerly used, the average power required by a 16-in. cold rolling mill was 144 kw. After changing to a grease containing graphite the average power dropped to 108 kw., representing a saving of 36 kw. On the basis of 20 hours' operation a day, 24 days a month, the monthly saving in power amounts to $129.60. Deducting $4 a month for the increase in the cost of the grease, leaves a net saving of $125.60 monthly, or $1,507.20 annually on each mill.

71 Studies of lubrication requirements and practices in a Middle-Western rubber plant have resulted in reducing lubrication costs, including material and labor, from an original index cost of 150 for each 1,000 lb. of product to the present index of about 47. Annual production approaches 200,000,000 lb.; savings are estimated at nearly $200,000.

72 In an Eastern plant the average power required by a 60-in. mill rolling sheet zinc was 350 kw. After a change was made to a roll-neck grease containing graphite it was found that the power required had dropped to 330 kw., representing a saving of 20 kw. With a power cost of $0.0125 a kilowatt-hour the saving in power costs over a 10-hr. day, 24-day month, is $48, after deducting the increased cost of the grease, or a net saving of $576 a year.

73 In a Northwestern flour mill that has an annual capacity of 400,000 bbl., plant records showed that power consumption was 3.89 kw.-hr. a barrel with the lubricants then in use. Extensive tests with other lubricants showed a power consumption of 3.79 kw.-hr. a barrel, representing a saving of 0.10 kw.-hr. There was a reduction in the friction load from 160 to 148 kw., which amounts to 12½ per cent. At a power cost of 1 cent a kilowatt-hour the annual saving in power costs is $400. Reduced consumption of oil and less labor required for oiling and cleaning increase this saving.

74 A Middle-Western rubber reclaiming plant with an annual output of 14,000,000 lb. reduced the cost of repairs and maintenance from $3.007 to $1.297 per 1,000 lb. of rubber by a change to other lubricants. This reduction in maintenance costs amounts to nearly $24,000 a year.

Lubricating Equipment

75 High cost of lubrication in the plant of a Middle-Western manufacturer of heavy power apparatus resulted in a thorough study that disclosed inefficient practices and much waste of material. Complete revamping of all facilities was ordered. In the oil house large tanks were installed to permit purchase of some oils in tank car lots, at a saving of several cents a gallon over the price in drums, and up-to-date storage and dispensing equipment was put in. Standardized sizes of small pump cans were put in the numerous distributing stations. Oil and grease cans issued to oilers and operators were likewise standardized. Arrangements were made for daily deliveries, by an electric truck, of all supplies needed by the lubricant distributing stations. Installed cost of lubricant storage and handling equipment was $7,400. Total savings were $6,925 the first year. Return on the investment is 93.6 per cent.

76 Haphazard methods of handling lubricants in a Middle-Western steel mill were the cause of considerable waste and bearing trouble. Oils and greases were dispensed from the general store-room in barrels and drums which were placed at convenient locations around the mill. Contamination with mill dust increased bearing wear considerably. Eventually an oil house was erected for centralized handling of all lubricants. In it were installed storage tanks with motor-driven pumps and other modern equipment, including an oil purifier for reclaiming used oil. An efficient system of lubrication control was adopted. Elimination of waste has cut lubrication costs about $3,600 a year. These savings will pay for the storage and handling equipment in somewhat less than four years.

77 Investigation of lubrication practices in an Eastern metal-working plant revealed that 89 different styles or types of lubricating devices were in use on fifteen presses. A different type of oil had to be used in each of the different types of lubricators. When these devices were replaced by one type of lubricator, one grade of oil satisfactorily met all lubrication requirements. As a result oil storage and handling charges have been reduced greatly, the labor involved in lubricating the presses has been simplified, and no mistakes are made.

78 Lubrication of the trolley and bridge mechanisms of thirteen traveling cranes in a New England machine tool plant required that the men climb all around in order to reach oil and grease cups. Cost of bearing repairs was about $3,000 a year. Automatic pulsating oil lubri-

83 Installation of a full automatic centralized lubricating system on the six stands of a bar mill resulted in a power saving of more than 25 per cent. The bearings on this mill have shown an increase in length of life of more than 400 per cent. At the same time, rejections due to rolling off-gage material have reduced greatly.

Control Equipment

84 Replacing mechanical switches that were the cause of considerable trouble, a photo-tube control for a sheet catcher in a large steel mill has decreased operating and maintenance costs and increased production. Frequently damaged, the old switches required much attention and delayed production. The new control makes it possible to eliminate one or more men on a stand of rolls.

85 A large manufacturer of a bulk material that is sold in small packages has made substantial savings by installing automatic scales equipped with photo-tube control so that the flow of material into the packages is cut off immediately when the desired weight has been reached. Under-filling of packages has been eliminated; the material formerly lost through over-filling is saved.

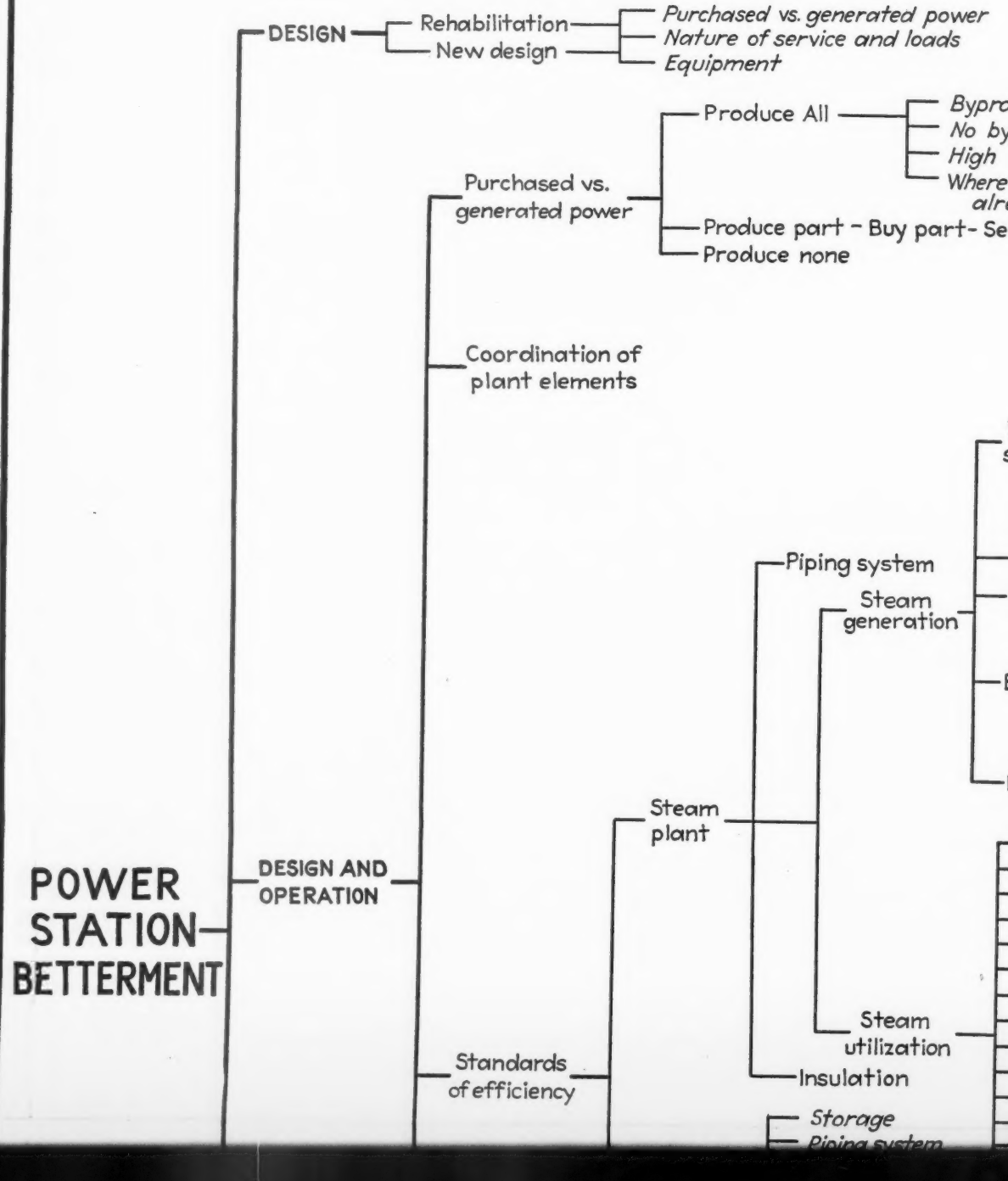
86 Capacity of a lifting magnet used in an Eastern steel mill for handling ingots was increased considerably by the installation of a new controller. Formerly the load on the magnet was released by a controller that had three positions: lift, off, and drop. With the controller that was used originally the ingots did not drop until six or seven seconds after current was cut off. Now they drop within three seconds. Less manipulation of the new controller is required because one function has been made automatic.

87 At an Eastern mine the mechanically operated switches employed to open the mine doors when a train of cars approached and close them after it had passed, were the cause of much trouble and delay. Maintenance costs on these switches were high. The troubles and delays stopped, and with them practically all of the maintenance charges, upon the installation of a door-opening mechanism controlled by a photo tube.

88 Bells of the blast furnaces in a Mid-Western steel mill originally were operated by steam-driven pistons controlled by the operator of the hoist that carries the charge to the top of the furnace. Manual control of the pistons was replaced with automatic electrical control. The cost of the automatic control was about $1,500. Savings in labor costs alone are estimated at $5,000 a year, which amounts to a gross return of 333 per cent on the investment.

89 In an Eastern plant manufacturing food products trouble was experienced in cutting the waxed paper in which some of the packages are sealed. It was impossible to avoid slippage or creepage of the paper while passing through the feeding rolls, with the result that the printed matter appeared in various positions on the package. The problem was solved by the installation of a photo-tube control that governs the rate of feed so closely that the paper is cut within 1/16 in. of the proper place.

90 A resistance welding machine used in the plant of a Mid-Western manufacturer for welding the bottoms of steel pails originally was equipped with a mechanical current interrupter. This device required overhauling every day. Output of the welder was about 200 pails an hour. An electron tube



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92 In an Eastern metal-working plant automatic control of the factory lighting system by photo tubes has reduced power consumption between 4,000 and 5,000 kw.-hr. a month, cut lamp replacements about 25 per cent, and increased output. The intensity of illumination in all areas is kept always at the desired value, but since full advantage is taken of natural daylight the lamps are burned only when necessary. As soon as daylight gives the required light intensity the lighting circuit is switched off through relays that are controlled by the photo tubes.

93 Motor-driven pumps in one of the deep shafts of a Western mining company raise mine water from two lower levels to a higher level, from which it is pumped to the surface. Manually operated equipment was used, and meant that careful, skilled men were required to insure proper working of the system, with the ability to handle any emergency that might arise. Automatic equipment was installed at a cost of about $8,000. In the first six months of operation a saving of $5,000 was realized, indicating that the savings may approximate $10,000 a year. At this figure the gross return on the investment is 125 per cent.

94 In the plant of a well-known manufacturer of linoleum 27 mixing machines were formerly driven by direct-current, adjustable-speed motors through large open, spur gears on which maintenance costs were high. Study of requirements led to the installation of full-automatic, two-speed control, using an alternating-current motor and speed reducer, on one unit. The new control provides automatic changing of speed and shutdown at the end of the mixing cycle. Records showed a saving in power of 15 to 20 per cent, with a considerable saving in maintenance costs and improvement in the quality of the product. As the result of this showing all of the 27 machines have been changed over to automatic control.

Electrical Instruments

95 Graphic instruments in an automotive engine plant showed how some large but hitherto unsuspected production losses could be reduced to almost nothing. For example, power consumption curves showed that a loss of 10 to 15 per cent was caused by the slowness with which the men came up to full efficiency in the morning and after the noon hour, and by the slackening off before the noon hour and at night. This plant operates 800,000 man-hours a month; so a loss of 10 to 15 per cent in productive time amounted to a considerable sum of money. Measures were taken to correct these conditions, with the result that a daily loss of 91 min. was reduced to 14 min. a day. An 18-min. loss in the morning caused by the men waiting for material and instructions was likewise reduced to 2 minutes.

96 In a Cuban sugar mill a kilowatt-hour meter is permanently connected into the circuit of a 200-hp. motor that drives a set of revolving knives for cutting up the raw material going to the mill. The ratio of kilowatt-hours to tons per hour of material cut up gives a fair indication of the condition of the knives, and shows when they should be replaced. Also it records all idle time.

97 A graphic voltmeter is mounted on the switchboard in each of the four substations in one steel plant and permanently cut into the distribution system. Whenever a ground appears on any part of the system it is at once recorded on the chart of one or more of the meters. Rapid inspection of the chart enables the operators to determine the character and severity of the ground, making it easier to detect and clear. Use of these graphic meters has resulted in a saving of 26 per cent in the delays caused by grounds. There has also been a considerable saving in the maintenance labor and materials required to keep motors and other equipment in this steel mill in good condition.

It is very important that the mixture be of the proper consistency. It was found that the simplest way of determining this point was to place an ammeter in the circuit of the motor that drives the agitator. A glance at this meter will tell the operator whether the consistency of the material is too heavy or too light.

100 In a storage battery plant a large percentage of positive plates was rejected because of faulty mixing of the paste. Two inspectors would have been required to watch the seven mixing machines; so recording instruments were installed as an experiment on one mixer. The charts showed gross departures from the proper practice. When these were corrected rejections of plates were practically eliminated. Meters were installed on the remaining mixers and now serve to give closer control of the mixing process, both as to time of mixing and consistency of the ingredients, than otherwise possible.

101 A rubber company kept a main transformer bank on the line during the 36-hr. week-end shutdown, to supply a 2-hp. motor which operated continuously. Charts from a recording instrument showed that the week-end load, including the transformer losses, amounted to 9 kw. when the motor was running light. Substitution of a 1½-hp. motor operated from the lighting circuit, for the 2-hp. motor, and throwing the large transformers off the line over the week-end, saved 15,715 kw.-hr. consumption, or $314.30 a year.

102 In a Mid-Western plant the charts from a newly installed graphic wattmeter showed an occasional peak which fixed an unusually high demand for the entire month. It was then found that these peaks were caused by machines which operated intermittently being thrown on at times when the regular plant load was at a maximum. With this information at hand it was a simple matter to arrange production schedules so that certain machines were idle when the desirable maximum load was reached. In this way the demand was reduced 230 kw., at a yearly saving of $3,450, without adversely affecting plant operation.

103 In a metal refining plant four mixing machines are in continuous operation. On account of overloads which damaged the stirring mechanism one of these machines was formerly out of service on an average of once every two months. The cost of repairs was usually about $500, and the delays occasioned a production loss of about 25 per cent. Such breakdowns were completely eliminated by the installation of graphic wattmeters that warn the operators when the load becomes excessive. The meter charts are filed and furnish a continuous record of the operation of this department. These meters have also been of great service in helping the operators to keep the consistency of the mix at the proper value. If the mixture is either heavier or lighter than it should be that fact is immediately recorded as a lighter or heavier load on the motors.

Lighting

104 About once a week it was necessary to replace at least one lamp in a group of five 750-watt units mounted high above the floor in one department of a glass works. Conditions made the replacement of lamps a very hazardous job. To eliminate the injury hazard the lamps were mounted in disconnecting hangers equipped with shock absorbers. Then it was found that the average life of a lamp was increased from a week or two to about seven months, and investigation showed that the excessive breakage of filaments had been caused by the vibration of a large turbine in the same building. The cost of the disconnecting hangers was $90 and it is estimated that they will pay for themselves about every eight months.

105 A silk hosiery plant was originally laid out for localized lighting, using 60-watt lamps in tin shades on drop cords spaced 5 ft. apart. This arrangement was replaced by special reflectors equipped with 100-watt, bowl-silvered lamps, in alternate outlets only. Illumination was increased about 50 per cent, and an even distribution of light effected. Each 100-watt unit installed in place of two 60-watt lamps means a saving of 20 watts per unit. The net saving in current cost is 60 cents per unit per year, which will pay the entire cost of the installation in about five years.

106 An investigation in a large steel mill showed that about 35 per cent of the lamps rated 400 watts or over were left burning when not needed. The lighting load in that mill is about 400 kw. As the result of an educational campaign the percentage of lamps left burning in the daytime, or when not needed, was reduced to 5 per cent. This means a saving of 1,440 kw.-hr. per day, or $5,400 annually.

107 Replacing an old type of semi-indirect fixture with standard R.L.M. domes mounted on disconnecting hangers made possible a saving estimated at $25 per fixture per year in a large power house. Also, a serious injury hazard to workmen replacing lamps or cleaning fixtures was eliminated. The new fixtures made it possible to use 500-watt lamps in place of the 750-watt size previously used, resulting in a saving in cost of lamps and in current consumption which pays for the fixtures in somewhat more than a year.

108 An increase in the intensity of illumination became imperative in the warehouse of a large steel company. It was eventually decided to increase the reflection factor of the walls and ceiling by painting them. One coat of a flat white paint was sprayed on at a cost of $450. It was then found that the 1,000-watt lamps previously used could be replaced with 500-watt lamps, since the intensity still was higher than it had been before. Cutting current consumption in half in this way resulted in a saving conservatively estimated at $936 a year.

109 In an automotive parts plant in which 5,700 Glassteel diffusing units are installed an average of 8 minutes was required to clean each unit by the methods formerly used. To clean all units took about 760 hours. With labor at 62 cents an hour and four washes a year the annual cost of cleaning lighting units was $1,884.80. Use of disconnecting hangers made it possible to cut the cleaning time to 2½ minutes per unit. With the same labor rate the cost of four complete washes a year was reduced to $589—a saving of $1,295.80 a year.

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The plant is located in a semi-residential neighborhood, so the practical elimination of the smoke nuisance is an important by-product of the new installation. Coal is delivered in bottom-dump cars which empty into a track hopper. A chain-driven belt conveyor carries the fuel into a 200-ton overhead bin, whence it is conveyed to the stoker hoppers via traveling bucket and electric hoist. The bucket is of 750-lb. capacity—just big enough to fill a stoker hopper.

Stokers

11 The Waukesha Motor Company, Waukesha, Wis., installed stokers under three of the six hand-fired boilers required to carry the load. During the first three months of operation savings in coal and labor were $2,714, or 31 per cent. Stokers increased the capacity of the boilers so much that the entire steam load can be carried by the three stoker-fired units.

12 Less than two heating seasons sufficed to pay for a stoker installation out of savings, at the plant of the American Colortype Company, Chicago. The boiler, a 150-horsepower tubular type formerly was hand-fired and in the last year previous to installation of the stokers the coal bill was $7,459. The next year it was $5,267, representing a saving of $2,192. Cost of stoker and instruments to insure proper operation was about $3,000, which was returned in considerably less than two years. With full allowance for interest and depreciation, the return on the investment is about 58 per cent.

13 Six stokers in the brewery of Miller High Life Company, Milwaukee, have cut the cost of producing steam from 49.2 cents a thousand pounds to 31.4 cents, a saving of 7.8 cents. This improved performance is largely due to the fact that the stokers can handle screenings that cost anywhere from $1 to about $2 a ton less than the lump coal burned with hand firing.

14 Modern coal burning equipment—stokers, as it happens—enable the Metal Door & Trim Company, LaPorte, Ind., to save $2,799.81 in one year. That was more than enough to pay for the installation. From now on a similar amount will appear somewhere on the black ink side of the ledger.

15 The existing boiler plant in a small Ohio metal-working establishment was revamped by rebuilding the furnace, installing a stoker, feed water heater, and soot blowers. With an expenditure of about $15,000 the saving in fuel cost amounted to nearly $8,000 the first year. Allowing for interest on the investment, the new equipment paid for itself in two years.

Pulverized Fuel

16 In an Indiana meat packing plant a combination stoker and pulverizer unit which maintains a firebed while burning a portion of the coal in suspension has cut coal tonnage by more than 15 per cent, permitted the use of a ⅜-in. screening that is 50 cents a ton cheaper—a total saving of 30 per cent in the fuel bill. Also, the cooking-room foreman reports a saving of about 30 hours labor a month as a result of constant, dependable steam pressure.

17 A similar installation in a Massachusetts brick manufacturer's plant afforded a $625 gross saving in fuel in five weeks as compared with hand-fired operation over a like period. Coal consumption was reduced from 251 tons at $5.40 to 170 tons at $4.30. Production during the second period was 13 per cent lower, so the actual fuel saving was 38 per cent.

18 Early this year Antigo Milk Products Cooperative, Antigo, Wis., bought coal pulverizers to fire two Scotch marine-type boilers. An engine-generator set was also installed so that this concern could make the major part of its power requirements. Savings in fuel cost were about $1,000 for May alone.

19 Minneapolis-Honeywell Regulator Company, Minneapolis, stopped firing by hand, equipped two 150-hp. horizontal return tubular boilers for pulverized coal. Two other small boilers are oil-fired. During the first heating season after this equipment was installed the company saved 17½ per cent in coal bills, made a further saving in the amount of fuel oil consumed.

20 Installation of a unit pulverizer for firing an 805-horsepower boiler makes it possible for the Orenda Corporation, Wilmington, Ill., to burn 3/16-inch strip-mine duff, which can be obtained for about $1.19 a ton less than the size of screening previously used. Along with a large saving in fuel costs, has gone an increase in the over-all efficiency of the boiler room.

27 A boiler meter provided Schaffner Bros. Co., packers of Erie, Pa., with accurate data for fuel selection. This concern purchased a number of grades of coal of different prices and varying freight rates, used the meter to check boiler output, found it got more steam for its coal dollar by buying a more expensive coal with a lower freight rate. The flue gas temperature recorder of the boiler meter serves as a guide to soot blowing.

28 An Eastern concern installed boiler meters on four 254-hp. hand-fired boilers that used a mixture of anthracite screenings and bituminous coal. After a short time the meter supplied information which caused the company to change the ratio of anthracite to bituminous. A saving of $1,000 a month returns the cost of the meters four times annually.

29 Five boiler meters are credited by Spalding Fibre Company, Tonawanda, N. Y., with gross savings of $500 a month in its stoker-fired steam plant. Actual tests with and without these guides to economical combustion showed a 10 per cent saving when the firemen kept their eyes on the air-flow and steam-flow pens. Deduct from gross savings depreciation and interest charges on a $3,500 investment, cost of charts, and maintenance. Net annual saving remains $5,334.50; net annual return on the investment, 152 per cent.

30 Following the installation of a meter for recording steam and air flow, flue gas temperature, and furnace draft, in the boiler plant of a Southern paper mill, the average evaporation per pound of coal rose from about 8.9 to 9.6. The savings in fuel amount to $24,000 yearly, at which rate the metering equipment pays for itself every 46 days.

31 Savings in fuel amounting to about $2,300 a year were made possible by the use of recording pyrometers in a Middle-Western plant manufacturing glazed tile. There are five glazing kilns, each of which is equipped with a thermo-couple connected to instruments located in the foreman's office, so that he can determine at a glance whether the kilns are being properly fired. Savings due to reduced spoilage are important, but are not included in the figure given.

32 A saving of more than $650 a year in the cost of steam alone was realized by an Eastern chemical plant through the installation of an automatic temperature control for one unit of equipment.

33 An Eastern manufacturer of non-ferrous alloys installed a meter which records the steam flow, draft, and flue gas and steam temperatures. Changes in practice indicated by study of these records have resulted in a saving of $260 a month, or more than $3,100 a year. The meter pays for itself every few months.

34 Accurate records taken in the plant of an Eastern carpet manufacturer showed an increase of nearly 9.7 per cent in steam production per gallon of fuel oil, following the installation of a CO_2 recorder. This increase in efficiency represents a saving of $1,200 annually—a return of 358 per cent on the investment.

35 In a Middle-Western plant manufacturing enameled wire, rejections due to improper annealing or baking of the coating ran about 7 per cent of the output. Installation of automatic temperature controllers on the annealing furnaces and baking ovens reduced rejections to 2 per cent. Savings amount to about $3,300 a year—a return of 76 per cent on the investment.

36 University of Kansas generated its own steam, purchased power only in emergencies. A survey showed that power could be purchased to advantage in warm weather, that a non-condensing turbine would provide new economies in winter. Annual operating costs, since the change-over, have been reduced 40 per cent, the turbine alone saving more than $7,000 a year.

Prime Movers

37 In a New England plant a corliss engine driving a 150-kw. generator supplied part of the power requirements. The remainder of the power was purchased. Steam required for process was less than the amount furnished by the engine when operated at full capacity. A 150-kw. diesel engine was installed to replace both purchased power and some of the current generated by the corliss unit so that the latter could be operated in accordance with the demand for process steam. Estimates show the saving will be more than $5,000 a year, which is sufficient to retire the investment cost in four years.

44 stokers in the Hoover Company's plant, North Canton, Ohio. A steam engine installed adjacent to the boilers and direct connected to the stokers brought that figure down to $167 a year. Net annual savings, $343. Annual return on investment, 67 per cent.

45 Byproduct power saves Moulding-Brownell Corporation $765 a year. Three 150-hp. boilers supply steam. A 30-kw. d. c. generating set receives saturated steam at 115 lb. pressure, generates 68,000 kw.-hr. annually, and returns the exhaust to steam-heating coils in a kiln where molded blocks are dried preparatory to firing. The low maintained steam rate of this generating set is responsible for proper heat balance and low power cost—slightly over ½ cent per kw.-hr. compared with the local utility rate of 1.7 cents at the time the installation was made.

46 An old steam plant in the mill of the Wm. E. Hooper & Sons Company, Baltimore, was replaced by two 950-horsepower diesel engines direct-connected to generators. Savings over previous power costs are in the neighborhood of $4,000 a month.

Power Factor Correction

47 More power was what a West Coast lumber concern needed most. Investigation showed that the generator was running hot, power factor was low. For $9,200 the company installed a surface air cooler for the generator, and a 1,000-kva. synchronous condenser. Result: $3,700 saved every year, power factor improved, enough power for every need.

48 An Eastern plant that makes shoe soles had a connected load of 975 hp. in induction motors and 25 kw. in lighting and electric heating. Plant power factor was 62 per cent at maximum demand. When it became necessary to install several more machines calling for an additional 325 hp., study of the requirements resulted in the installation of four synchronous-type induction motors. Power factor was raised to 91 per cent. If induction motors had been used the plant demand, at a power factor of 62.6, would have been 772.3 kva., and the monthly demand charge, $721.32. With the type of motor chosen the demand is 528 kva., with a demand charge of $501.45. The monthly saving on the demand charge is $219.87, or $2,638.44 a year. On this basis the synchronous-type motors will pay for themselves in about two and one-half years.

49 Two 1,300-kva. capacitors installed in a Mid-West steel mill saved $8,100 a year on the power bill, representing an annual return on the investment of 31 per cent. This reduction in power costs was brought about by improvement in power factor, and decreases in idle current, line loss, and voltage drop.

50 A manufacturer of motorcycles was offered an advantageous power contract provided the power factor was kept at 85 per cent or above. The plant load comprises 104 induction motors ranging from 1- to 150-hp. rating, with an aggregate rating of 1,850 hp. The power factor was normally 70 per cent. Following installation of a 270-kva. capacitor the power factor rose to 90 per cent. At this figure the average monthly saving in power costs is $757, or $9,084 a year. Deducting all charges leaves a total net saving of $8,287.50 annually on an investment of $5,000. Return on the investment is 165 per cent.

51 A Mid-Western sash and door plant supplies its own power by operating a generator rated 350 kw., 80 per cent power factor. With a load of 321 kw. at 65 per cent power factor over-excitation was required and heating was excessive. For three squirrel-cage motors driving fans, a load of 111 kw., power was purchased at a cost of about $500 a month. Three synchronous-type induction motors totaling 130 hp. were installed to replace the other three motors and supplied from the generator. Power factor was raised to 82.5 per cent. Besides improvement in voltage regulation there has been a saving of $6,000 a year in energy formerly purchased.

52 In an Eastern plant manufacturing gloves 42 ⅓-hp., three-phase, 60-cycle, 208-volt motors driving sewing machines operated at full load about half the time and idled the remainder. Power factor was about 56 per cent. Installation of individual capacitors on all motors raised the average power factor to 90 per cent. The net saving in power costs, after deducting all charges, amounts to $106 a year. Cost of capacitors installed was $282, making a return on the investment of 37.5 per cent. In addition, the output of the machines was increased 5 per cent, by reason of the higher motor speed and quicker acceleration from reduced voltage drop due to power factor correction.

lation cost.

62 In a Southern textile mill ball-bearing pillow blocks were installed on four spinning frames, replacing the plain bearings originally employed. Installation cost of the new bearings was $250. Power requirements were reduced so much that the savings in this item, together with the reduction in lubricant and labor costs are estimated at $262 a year. Annual return on the investment is 105 per cent.

63 A manufacturer of laundry machinery was able to save more than $200 a month by using self-lubricating bearings in the pulleys of these machines. The pulleys are located in an out-of-the-way place where they are likely to be neglected. Under his guaranty the manufacturer was obligated to install new shafts, pulleys, and bearings when failure occurred. Self-lubricating bearings have eliminated such cases.

64 Ball bearings were installed on three lineshafts, each approximately 80 ft. long, from which 20 cigarette machines are driven in a Southern tobacco factory. Power load with the shafts running in babbitted bearings was 40.13 hp., on the average. After the installation of ball bearings the load dropped 13 per cent, to 34.73 hp., a difference of 5.40 hp. At 3 cents a kilowatt-hour the yearly saving in power bills is $326. Added to this is a saving of $23 in labor required for lubrication and about $7 saving in oil. After allowing all fixed charges the total net savings are $356 a year. Installation cost was $712; return on the investment is 50 per cent.

65 After replacement of practically all sleeve bearings on its line and countershafts with ball bearings, a large Middle-Western woodworking plant found that the reduction in friction losses had decreased power requirements about 17 per cent, which means a yearly saving of $1,553. This saving is based on a power cost of 1 cent a kilowatt-hour, since this mill generates its own power largely from wood waste. If power were purchased, the saving would probably be more. A further saving of about $300 a year in lubrication costs, representing a reduction of 88 per cent, brings the total to $1,853. Also bearing troubles on the line- and counter-shafts practically have disappeared. Results obtained in this application led to the replacement of the bronze sleeve bearings on certain woodworking machines with ball bearings. Troubles caused by the old bearings were eliminated through this change.

66 Ball bearings in hangers supporting lineshafts in the plant of a Middle-Western manufacturer of soaps and cosmetics cut the average power requirements about 8 per cent, thus saving about $1,745 a year. An incidental advantage has been a reduction of nearly $60 a year in the cost of lubrication. The ball bearings are lubricated four times a year; plain bearings required lubrication once a week. Brass thrust bearings in one of the production machines in use formerly caused much trouble and expense. Subjected to a thrust of around 20,000 lb. these bearings lasted from two to eight months. They were replaced with ball thrust bearings and no further trouble was experienced.

Lubricants

67 At an Eastern paper products plant excessive amounts of carbon in the air compressors necessitated cleaning the valves once every two weeks. Investigation disclosed that the wrong grade of oil was being used and fed at the rate of 96 drops a minute. After another lubricant was substituted the rate of feed was immediately reduced to 20 and eventually to 4 drops a minute. Any reduction in the rate of feed with the oil previously used had caused the pistons to groan and squeal.

The compressors have now been operated for more than six months without drawing the valves, whereas previously they were cleaned every two weeks at a cost of $5 a valve. There are four valves in each compressor; hence, the saving is $40 a month or at the rate of $480 a year on each one. Although the new oil costs about twice as much as the other there is a considerable net saving in the annual cost, since consumption has been reduced greatly.

68 Bearings on three miles of lineshafting in one large plant were formerly lubricated by bottle oilers feeding ordinary red engine oil. Refilling was necessary every eight days and required the services of a head oiler and two assistants. A special oil that was developed expressly for lineshaft lubrication was substituted for the other oil. Subsequent experience showed that the feed could be reduced so much that refilling of the bottle oilers was required only every 64 days, thus eliminating seven out of every eight fillings. The savings in the cost of lubricant were large, and greater still in the cost of labor for oiling.

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centralized handling of all lubricants. In it were installed storage tanks with motor-driven pumps and other modern equipment, including an oil purifier for reclaiming used oil. An efficient system of lubrication control was adopted. Elimination of waste has cut lubrication costs about $3,600 a year. These savings will pay for the storage and handling equipment in somewhat less than four years.

77 Investigation of lubrication practices in an Eastern metal-working plant revealed that 89 different styles or types of lubricating devices were in use on fifteen presses. A different type of oil had to be used in each of the different types of lubricators. When these devices were replaced by one type of lubricator, one grade of oil satisfactorily met all lubrication requirements. As a result oil storage and handling charges have been reduced greatly, the labor involved in lubricating the presses has been simplified, and no mistakes are made.

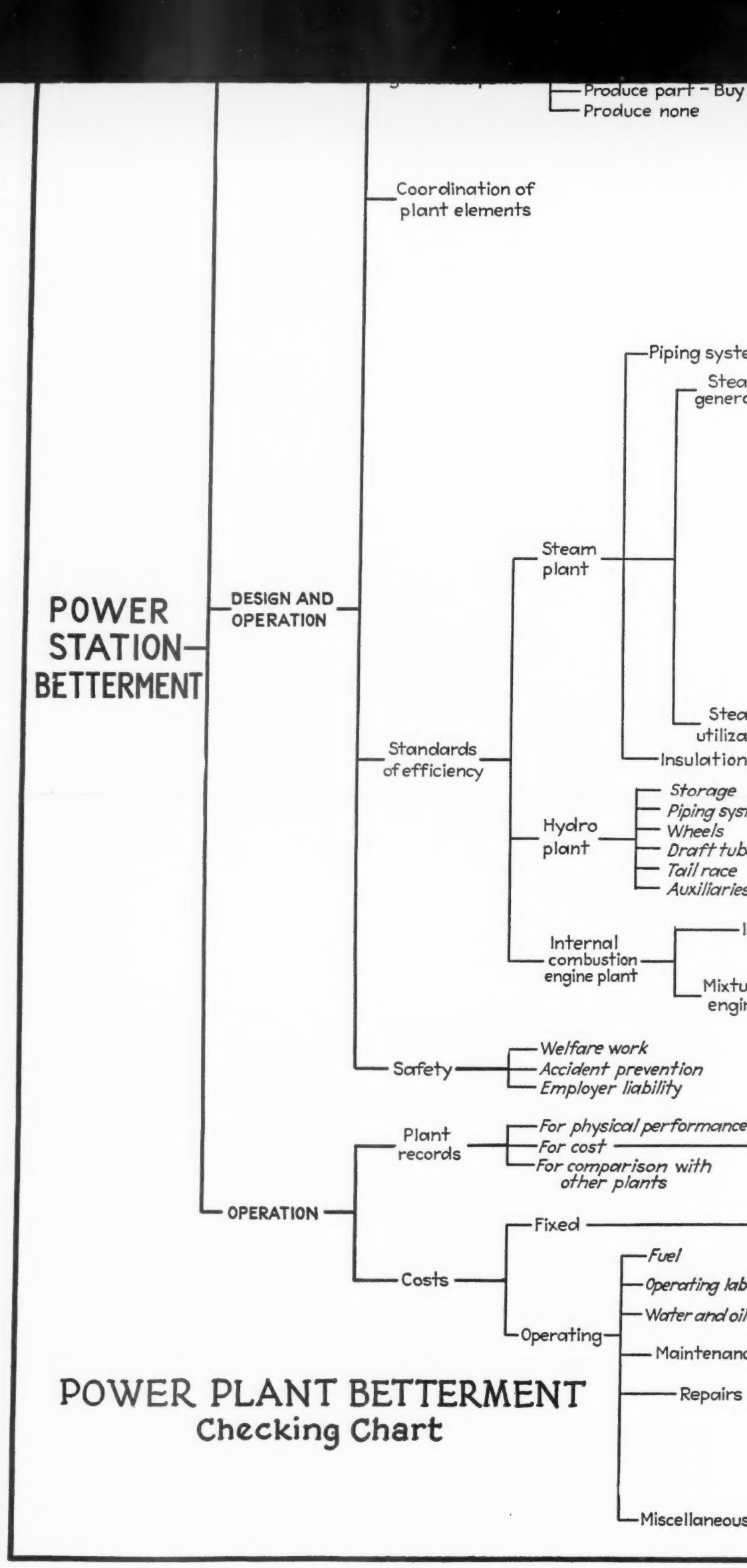
78 Lubrication of the trolley and bridge mechanisms of thirteen traveling cranes in a New England machine tool plant required that the men climb all around in order to reach oil and grease cups. Cost of bearing repairs was about $3,000 a year. Automatic, pulsating oil lubrication systems were installed on all cranes at a total cost of less than $3,000. No bearing repairs have been necessary since then; so these lubrication systems pay an annual dividend of 100 per cent.

79 A Southern plant that operates two 120-hp. diesel engines changed the oil every two months, at a cost of about $300 a year. A centrifugal oil purifier was installed at a cost of about $500. It has not been necessary to change the oil in the engines since then. The savings are $300 a year, or about 60 per cent on the investment.

80 Frequent, costly repairs required by a battery of automatic chucking machines in a metal-working plant led to the installation of an automatic, forced-feed, oil lubricating system. Power consumption has been reduced more than 10 per cent. Bearing troubles have been almost eliminated, accuracy of the work has been increased, output of the machines stepped up, and oiling and maintenance costs have been cut to a small fraction of the former value.

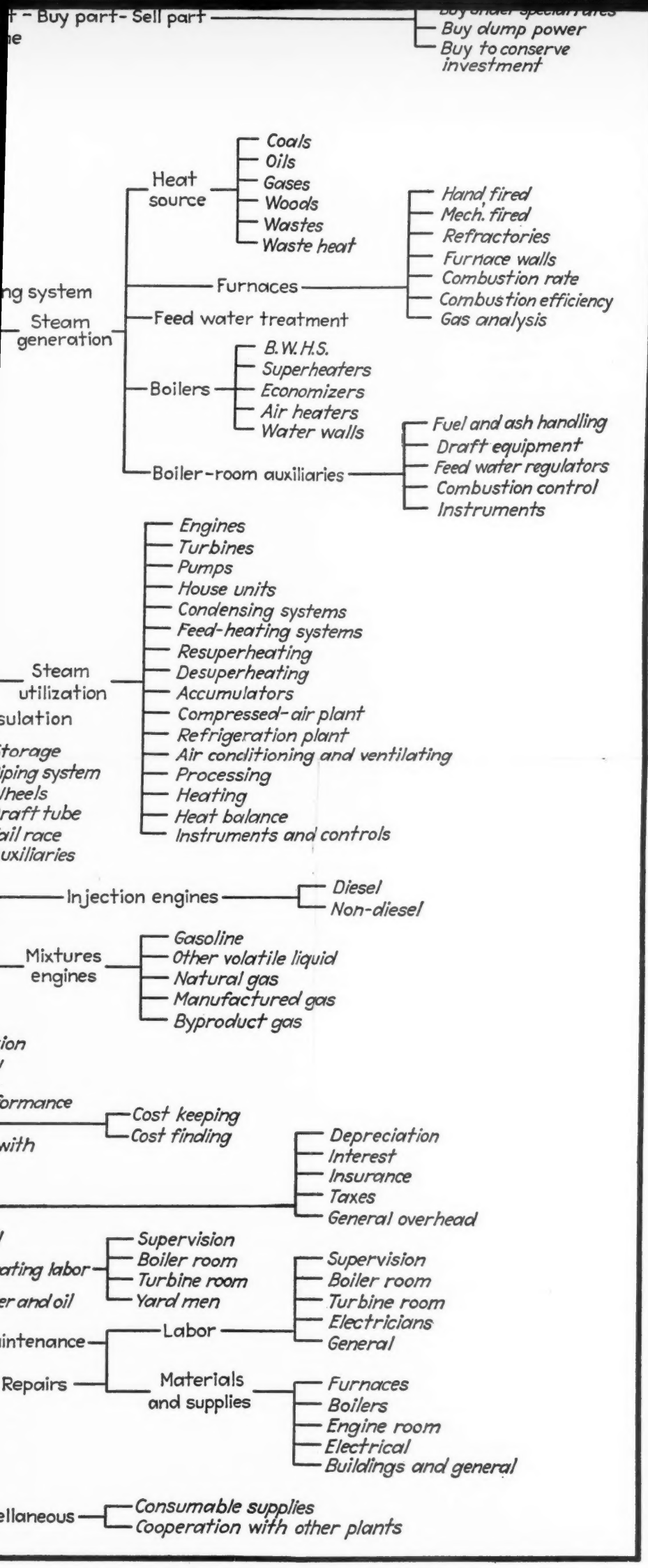
81 In a plant that generates 4,000 hp. from five diesel engines the lubricating oil in each unit was replaced every two months. Pending installation of a centrifugal oil purifier, it was decided to save the oil drained from the engines. After the purifier had been installed, the used oil in storage was treated and returned to service. The saving was $2,000, which more than paid for the oil purifier.

82 An Eastern printing press manufacturer applied automatic oil lubrication systems to a model that has 200 places that need lubrication, replacing hand-filled oilers that took from 20 to 25 min. a day to fill and manipulate. These systems start and stop with the press and save not less than 15 minutes a day of press time, about half the cost of the lubricants previously used, and $50 a year in wages. In addition there is a considerable saving in the cost of bearing repairs.



control increased the output of the machine 50 per cent, to 300 pails an hour. Maintenance costs practically have been eliminated, since the new control requires no attention.

91 Power consumption of nine traveling cranes in the foundry and machine shop of an Eastern manufacturer of heavy machinery was reduced about 25 per cent by replacing the controllers. The cranes originally were equipped with a conventional dynamic system of lowering control. The new controllers make possible higher speeds and more accurate control while lowering the load. Power peaks are reduced and when heavy loads are being handled more power is returned to the line.



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98 Recording wattmeter charts from an instrument cut into the circuit of a motor driving a large power press in a metal-working shop showed 26 per cent of non-productive time out of the total hours worked. Investigation revealed that this loss of time was due to trouble with dies and waiting for stock. When these conditions were remedied, the productive time of the press was brought up to an average of 95 per cent.

99 An instance of where electrical meters are used for definite and close control of an exacting process is found in the plant of a concern that manufactures phonograph records from plastic materials, which are thoroughly mixed in an agitator.

107 Replacing an old type of semi-indirect fixture with standard R.L.M. domes mounted on disconnecting hangers made possible a saving estimated at $25 per fixture per year in a large power house. Also, a serious injury hazard to workmen replacing lamps or cleaning fixtures was eliminated. The new fixtures made it possible to use 500-watt lamps in place of the 750-watt size previously used, resulting in a saving in cost of lamps and in current consumption which pays for the fixtures in somewhat more than a year.

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Electric Heat

111 Tests conducted by metering the gas consumed by a 1-ton electrotype furnace in an Eastern printing plant showed that the cost of operation, with a minimum gas rate of 65 cents per thousand cubic feet, was $0.235 an hour. Immersion-type electric heaters were installed, and a six weeks' test indicated that the cost of operation, under a power rate of $1.25 a kilowatt demand charge, and an energy charge of $0.01 a kilowatt-hour, was $0.162 an hour, or a saving of $0.073 an hour over the former cost. This furnace operates about 3,400 hours a year. On this basis the annual saving is about $250.

112 Savings of more than $500 a month followed the installation of electric hardening and tempering furnaces in the plant of an Eastern manufacturer of axes and tools. With fuel-fired equipment much difficulty was encountered in securing uniform heat-treating; rejections in the plant and in the field were the source of considerable loss. Thermostatic control made it possible to keep the temperature within much closer limits than had been possible before. Low operating costs of the electric furnace, with sizable reductions in the amount of labor required and the number of rejections, resulted in the savings mentioned above which will pay the cost of the new equipment every eighteen months.

113 An Eastern manufacturer of automobile axles and similar parts became dissatisfied with the quality of the work turned out by the fuel-fired, heat-treating furnace then in use. The resulting investigation led to replacing these furnaces with the electrically heated type. Savings in the number of rejects due to improper heat treatment, with lower labor, maintenance, and operating costs, amount to about $970 a month, or $11,640 annually. At this rate, the return on the investment is 93.5 per cent.

114 In the plant of an Eastern cutlery manufacturer a large fuel-fired steam boiler is operated to furnish all steam requirements, including building heating and steam for the various manufacturing processes. Although steam is not required for building heating during the summer months, it was necessary to operate the boiler to supply the comparatively small amount of steam needed for process work. Following the installation of six electrically heated warming cabinets, one glue cooker, and two water tanks, at a total cost of $346, the aggregate saving in labor and fuel in the first year of operation was $426—a return of about 123 per cent on the investment.

FACTORY MANAGEMENT and MAINTENANCE

OCTOBER, 1934

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In Two Sections

SECTION TWO

A1—Base Contract Coal

1—Select base coal for maximum net steam per dollar realizable with existing equipment. See that the selected coal will not reduce maximum boiler capacity. Take into account ash disposal costs.

2—Change base coal when new equipment permits efficient burning of cheaper kinds.

3—Check reliability of source of supply, certainty of delivery, and storing properties.

4—Investigate the possibility of getting properly mixed coals to give the necessary characteristics at lower costs.

5—Balance the cost of new firing equipment plus cheaper coal vs. your present coal.

A2—Spot Coal

1—Investigate range of coals that can be burned in your equipment to avail of bargains.

2—Consider additional equipment for burning various local coal refuse as well as better coal.

3—Consider temporary oil firing with bricking-in of the stoker.

A3—Coal Yards

1—Modernize coal unloading and storage distribution facilities where necessary.

2—Check wind, weathering, fire, and moisture losses.

3—Consider the total fuel problem for a major change as to type of coal, oil or gas, and balance new equipment required for change against economy in fuel costs and increased capacity.

A4—Combustible Refuse

1—Will your equipment burn refuse: bagasse, bark wood, refinery coke, breeze, river coal, raw lignite, peat, etc.?

2—Install new equipment to utilize refuse.

A5—Fuel and Diesel Oil

1—In selecting fuel oil, rate it for B.t.u. net(minus hydrogen loss) per gallon.

2—Check actual sludge, its separation, removal, burning.

3—Check or install oil meters on delivery, supply, and return oil lines.

4—Consider peak load oil burners for coal boilers.

5—In selecting diesel fuel oil, rate it for B.t.u. net per gallon. Check maximum indicator pressure to avoid oils with delayed ignition, which cause more maintenance and trouble in cold starting.

6—In case of sluggish oils, try heating before admission to fuel pump.

A6—Ashes

1—Check present system of disposal, install mechanical or hydraulic transfer if quantity warrants. Check loading facilities if cinders are marketed.

2—Pipe fly ash pockets, arrange compressed air or water jets for transfer, provide clinker grinders.

3—Install fly ash collectors, precipitators, hydraulic transfer, settling tanks.

4—Analyze unburned combustible. Return fly ash rich in carbon to mills.

5—Consider slag tap bottom for pulverized coal boilers in case of troublesome ash.

6—Watch the unburned carbon in ash. Anthracite of various compositions must be rated minus heat in the unburnable residual carbon, which varies widely from coal to coal.

7—Analyze cinders often. They are worth returning to furnace.

B1—Coal Handling Equipment

1—Check labor and power required for present installation.

2—Consider a crusher and improved conveyors.

3—Check losses in transfer and wind losses.

B2—Coal Bunkers

1—Check capacity, provisions for spontaneous fire localization, vents, drainage if coal is stored under water.

B3—Coal Weighing Lorries

1—Periodically check the balance and coal car weights. Compare R.R. weights with your own. Install lorry if charging of hoppers requires excessive labor. Weigh all coal.

B4—Coal Mills (Central)

1—Consider pulverized coal firing to increase boiler capacity and to be freer in selection of coal. Are stokers worn out? Is a variety of coals available?

2—Select mill according to grindability of available coals. Replace old mills to save maintenance.

3—Install automatic mill control.

4—Check performance of mill parts, select more serviceable materials for parts where necessary.

5—Check steam consumption of coal dryer and consider use of flue gas.

6—Discard dryer, install heater for air to mills.

7—Control air temperature.

8—In a central (bin and feeder) system schedule mill operation for off-peak periods.

B5 and B6—Cyclone Separators and Pulverized Coal Pumps

C1—Mechanical Stokers
(Chain Grate)

1—Check adequacy of present type of stoker for the most economical coal.

2—Check the amount and disposal of siftings.

3—Check cooling of bins.

4—Check zoning of forced draft by dampers.

5—Check flexibility of stoker drive; consider variable-speed motors, hydraulic drive, steam engine.

6—Determine best depth of fuel bed, eliminate lane formation, maintain air zoning suitable to coal, give ample space for carbon burning.

7—Consider water-cooled boxes or abrasive brick lining along fuel bed to prevent erosion.

8—Consider seal to reduce excess air over rear end of stoker.

(Overfeed, Rocking, and Others)

1—Are they holding down the boiler capacity by too small surface?

2—Do they restrict you to burning expensive grades of coal?

3—Check the zoning of air.

(Underfeed)

1—Check life and maintenance of various parts, verify changes necessary.

2—Consider a new and longer stoker to use maximum capacity of the existing boiler.

3—Consider better distribution of air under stoker by additional zoning and control.

4—Consider new type of drive—hydraulic, variable speed, sectionalized.

5—Make full use of sectionalized features of fuel feed to avoid lane formation, adjust air to extension grates and to clinker pits.

6—Consider water-cooled or air tuyere protection for walls along fuel bed.

7—Check stratification due to clinkering in lanes by sampling gas across first pass.

8—Schedule the work of clinker grinders and adjust aprons.

C2—Oil Burners

1—Schedule lighting of burners with load, and provide various sizes of burner tips for good atomization at different loads.

2—Watch air supply to each flame.

3—Consider new burners, steam or mechanical atomizing for better combustion and lower loss of unburned oil, also combination burners with pulverized coal.

4—Keep the flame from impinging, which may result from poor atomization.

C3—Pulverized Coal Burners
(Turbulent)

1—Keep in continuous adjustment as to flame shape.

2—Replace obsolete by modern burner to save furnace maintenance and improve combustion.

3—Clean coke often.

4—Arrange steam injection for higher turbulence at peaks.

5—Provide adequate means of lighting.

6—Check position and flame direction; relocation of burners often helps.

(Long Flame)

1—Control primary air for proper flame length and direction.

2—Adjust flame direction in respect to secondary air jets; install auxiliary cross burners to shorten flame. Schedule lighting with load.

3—Install gas or oil pilot burners for floating bank load.

4—Keep the flame floating, not impinging on walls or boiler tubes.

5—Watch for uniform rate of firing by burners.

(All Types)

1—Consider slag tap bottom, vortex firing opposite burners, etc., before complete renovation of furnaces.

2—Check adequacy of air ports and of flow of secondary air in air-cooled furnace walls.

C4—Gas Burners
(Natural or Blast Furnace Gas)

1—Adjust air to burners for greatest turbulence and shortest flame, to avoid stratification and unburned-gas loss.

D1—Boilers
(Drum)

1—Install throttling calorimeter, check quality of saturated steam. Schedule water level vs. load, to keep moisture in steam low. Check steam separating baffles, dry pipe. In serious cases consider steam separators or purifiers. Install high and low water alarms, calorimeter temperature recorder.

2—Investigate your critical hydroxyl content (maximum concentration of salts) and maintain below the value found to eliminate sharp rise of wetness in steam.

3—In horizontal return tubular boilers use water level to pass sharp peaks.

(Blowdown)

1—Check blowdown connections, whether they drain places with maximum concentration.

2—For continuous blowdown arrange multiple drains, connect to manifolds.

3—Install improved blowoff valves. (See also 3 under F2.)

9—Check erosion of turbine wheels by wet steam. (Superheater may pay in lesser water rates and lesser maintenance.)

10—Check quality of exhaust steam if used for process (the latter usually improves with dry exhaust steam).

11—If your superheat is inadequate, especially at low loads, consider adding radiant superheating surface, which will also protect furnace walls.

12—Check the action of soot blowers on superheaters, schedule more often than for other parts.

D3—Economizers

1—Schedule washing and sand blasting of economizer surface.

2—Check leakage of air at boiler joints.

3—Repair water leaks immediately to avoid sulphuric corrosion.

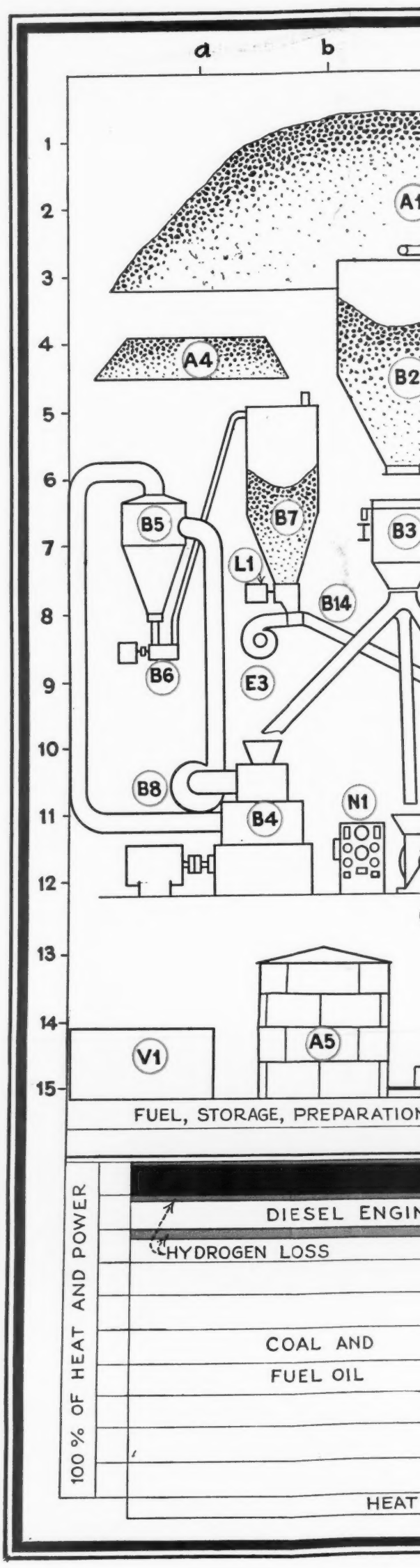
4—Avoid low gas temperature (below dew point); recirculate some gas at low ratings or banking.

5—Avoid using water at less than 180 deg. F. to reduce pitting.

6—Catch the moment when economizer needs retubing for putting in a new one with higher water velocities of improved type.

7—Consider installing economizer to improve efficiency, and to increase steaming capacity. Verify draft available; if not sufficient, consider revamping of firing equipment—to get maximum capacity with increased draft.

8—Consider a single economizer for a battery of boilers; connect to it gas from



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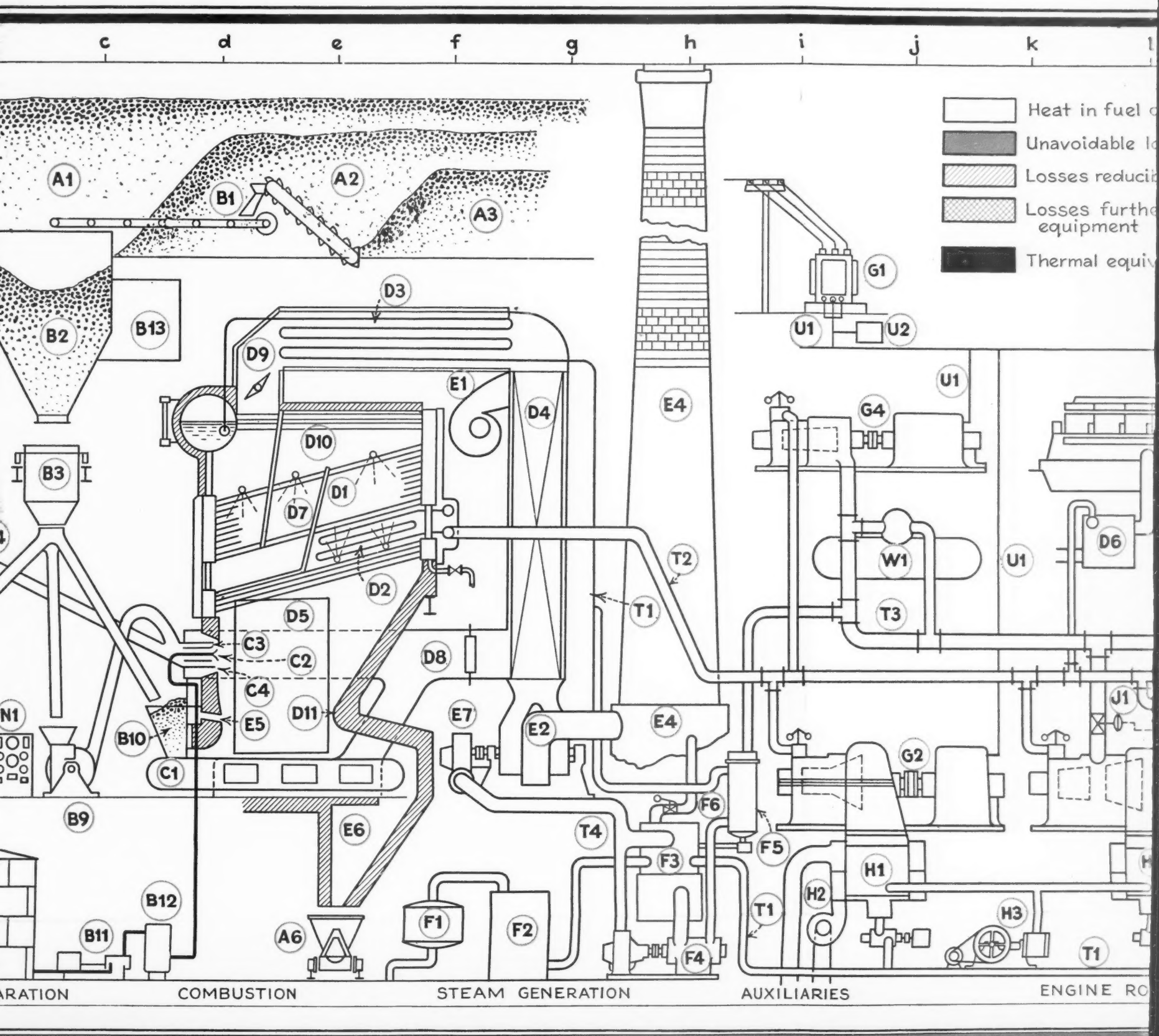
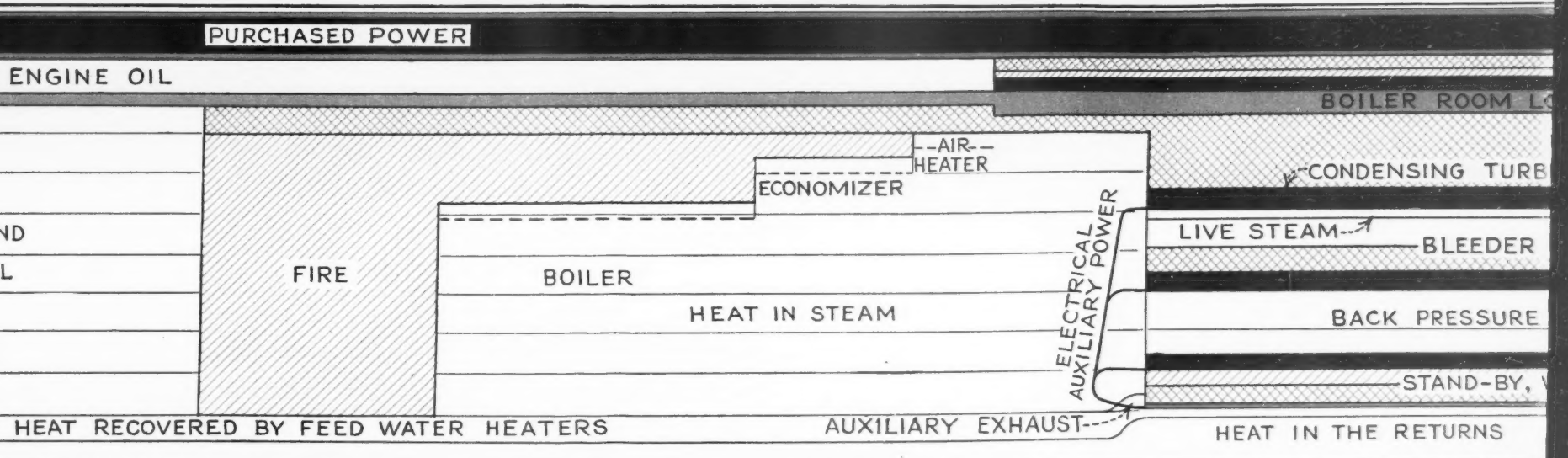
POWER LOSS

A Key to Industrial Plant Power Econom

Prepared by David Moffat Myers, Consulting





OW TO USE THE CHECK CHART

e two principal parts to the Power Loss hart: (1) an Industrial Plant Diagram; Both are arranged with certain sub- will become apparent upon examina- on reading the following paragraphs.

applies to a complex plant with a wide am and power purchasing, generating, ng facilities designed to include all s. It is not quantitative, but practically is comprised of parts shown in the a similar graph can be quantitatively o represent the exact heat balance in nt, from which an analysis of its losses

the graph is illustrative of heat and and output of each generating and nit as contained in the fuel, steam, and her electrical or mechanical. It traces s and losses from the original sources numerous steps of conversions, dis- nsformations, and applications to the the heat or energy that is actually re- factory products.

Engine Room

Total heat in steam enters the engine room and a large part of it is shown as consumed by turbo-generators. Note the loss of power in the electrically driven auxiliaries. The illustrated plant may be well run; but, for example, insufficient steam pressure may necessitate running the condensing unit and purchasing power. The condenser loss is cross-hatched in red, meaning that if a new high-pressure boiler and bleeder or back-pressure turbine were installed, a greater amount of power could be generated or the steam exhausted into process mains, and either the purchasing of power or the condensing operation might be eliminated.

The bleeder turbine condenser loss indicates conditions of operation when the process steam demand does not parallel the power demand during the fluctuations.

On the diesel-engine level the single and cross-hatched red streams indicate that part of the heat is recoverable by better loading schedule and part by installing waste heat equipment (see D6 and G5).

4—Install dust catchers; check carbon in fly ash; if high, return to furnace.

5—Consider a new stack, plain or in combination with cinder-catching equipment; consider brick lining for gas high in sulphur oxides.

6—Consider washing gas in the stack, lead- or tile-lined water pan, neutralization of sulphuric water by lime.

E5—Overfire Air

1—Consider jets of air above fuel bed for turbulence, better mixing of stratified volatile, and its better combustion.

2—Overfire air may help to cool arch tips and reduce flame erosion.

3—Determine the best amount of overfire air, especially for high-volatile coals.

E6—Ashpits

1—Consider clinker grinders vs. dump plates for stokers, or adjustable water back for chain grate stokers.

2—Schedule clinker grinder operation.

3—Install slag screen or water-cooled ash hopper in boilers converted to pulverized coal.

4—Consider possibility of a slag tap furnace if melting point of ash is too low.

E7—Induced Draft Fan Turbines
(Also Other Steam Auxiliaries)

1—Collect all the exhaust into open heater

F5—Clo

1—Check terminal proper air ventin condensate, press

2—Consider installi heater in the ab impossibility of u in case of bleede turbines.

3—Consider a low before the open steam flow is u steam auxiliaries a lower back pre their capacity.

F6—Open H

1—Check relief among condens units so that n feed water tem de-aeration is a

2—Consider the s balance for sum and, if the wa investigate the condensing uni

G1—Pu

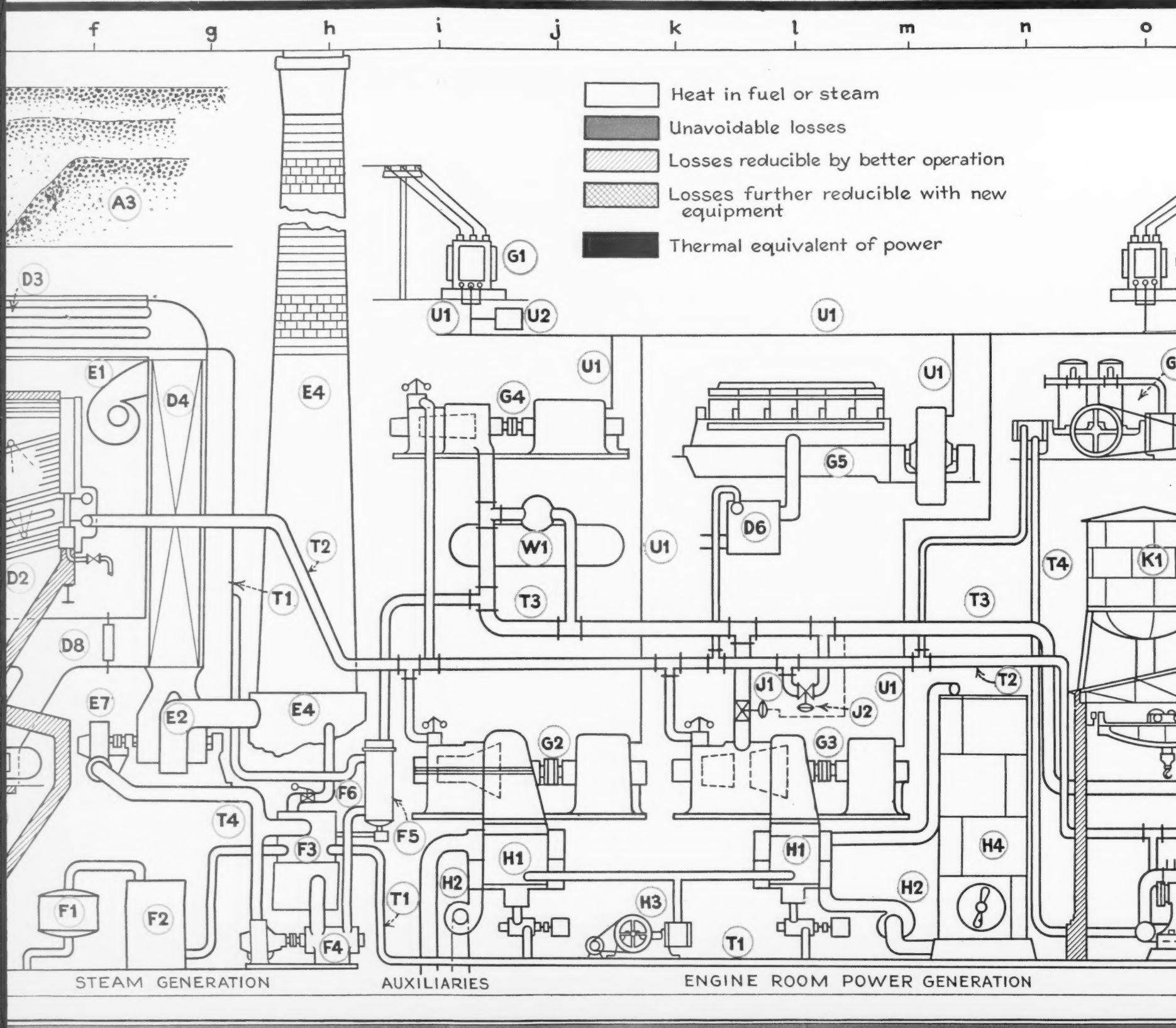
1—Study contra schedule load to Consider dema power factor; i stalling synch densers.

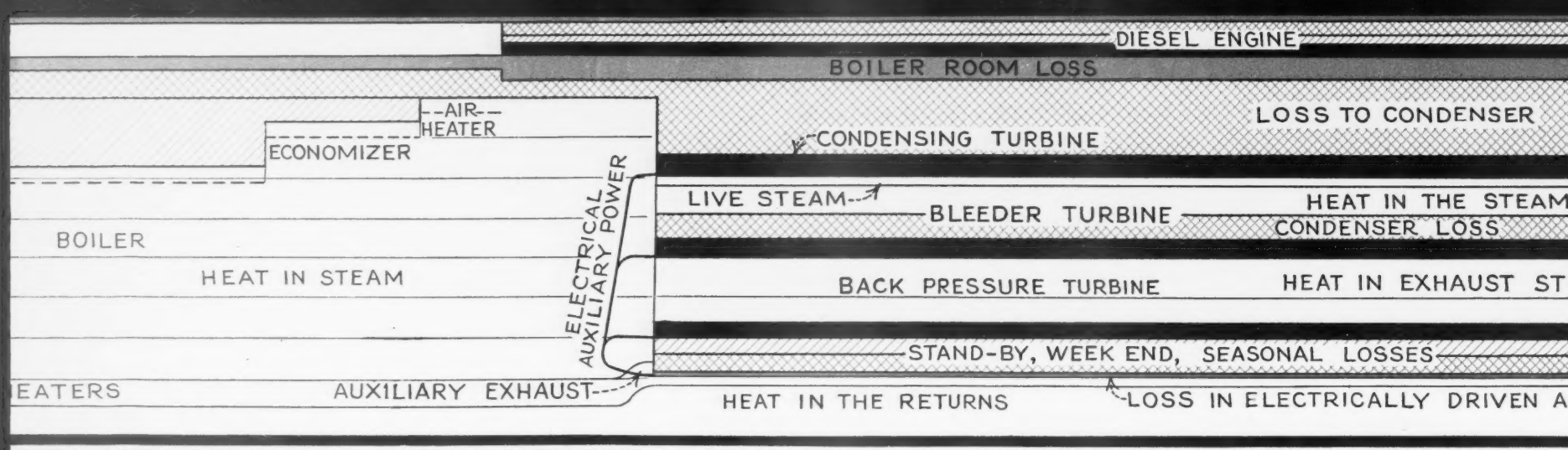
2—Consider furt

POWER LOSS CHECK

Key to Industrial Plant Power Economy and Graphic A

Prepared by David Moffat Myers, Consulting Engineer, and N. Artsay





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2—Schedule clinker grinder operation.

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4—Consider possibility of a slag tap furnace if melting point of ash is too low.

F5—Closed Heaters

1—Check terminal temperature difference, proper air venting, disposition of heater's condensate, pressure drop of steam supply.

2—Consider installing a high pressure closed heater in the absence of economizers or impossibility of using the latter, especially in case of bleeder or high back pressure turbines.

3—Consider a low pressure closed heater before the open heater if the exhaust steam flow is uneven, when some of the steam auxiliaries are short of power and a lower back pressure would help increase their capacity.

F6—Open Heater Relief Valves

1—Check relief pressure. Balance load among condensing and back pressure units so that no steam is wasted, proper feed water temperature is reached, and de-aeration is assured.

2—Consider the system's steam and power balance for summer and winter conditions and, if the wastage of steam is great, investigate the economies of extending condensing units or installing oil engines.

G1—Purchased Power

1—Study contracts carefully. Try to schedule load to avoid high peak demands. Consider demand limitation. Watch

5—Consider improvement of the where power is purchased and s used for process, by covering al demand by the back pressure turb purchasing less power. Also an o densing plant may be improved superimposed high-pressure turbi boilers.

G5—Diesel Engines and Gene

1—Schedule running in respect to units and process steam demand.

2—Schedule methodic maintenance

3—Check performance of the engi fuel by frequent indicator diagra

4—Use light oils for starting in cold w when engine is below 45 degrees provide for hot water circulation

5—Give three-quarters to full load running.

6—Check clearness and temperature haust; quality of cooling water.

7—Install recirculation.

8—Consider installing a diesel engi steam plant as a standby for nig week-end loads to reduce low lo banking losses.

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10—Install complete lubricating oil r ing systems.

K CHART

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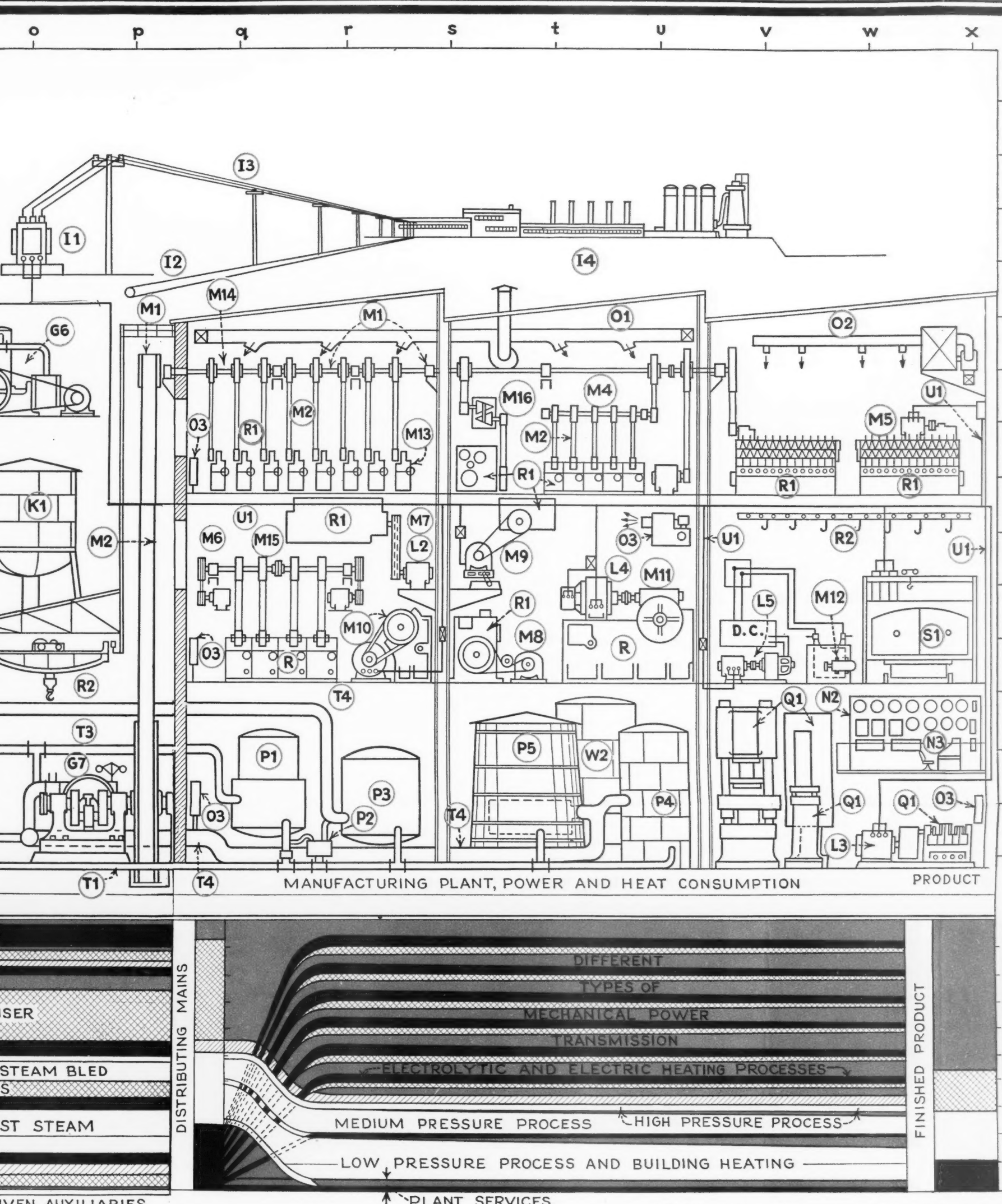
Artsay, Mechanical Engineer



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KEY TO LOCATION OF EQUIPMENT

Part	Symbol	Location
Accumulators, hot water	W2	13-t
Accumulators, steam	W1	8-j
Air, interconnections for	I2	4-p
Air, overfire	E5	11-d
Air Conditioning	O2	5-n
Arches	D11	11-e
Ashes	A6	15-e
Ashpits	E6	12-e
Baffles	D7	7-e
Bearings	M13	7-s
Belts	M2	7-r, 7-t, 10-p
Bins, pulverized coal	B7	7-b
Blowers, soot	D10	6-e
Boilers	D1	7-e
Boilers, waste heat	D6	8-l
Bunkers, coal	B2	4-c
Burners, gas	C4	10-d
Burners, oil	C2	10-d
Burners, pulverized coal	C3	10-d
Capacitors	U2	4-j
Clutches, friction	M15	9-q
Coal, base contract	A1	2-c
Coal, spot	A2	2-e
Coal Handling Equipment	B1	2-d
Coal Yards	A3	2-f
Combustion Control, automatic	N1	11-b
Compressors, air	G6	6-o
Condensate Returns	T1	9-g, 14-h

Part	Symbol	Location
Machines, production	R1	8-q, 8-s, 8-t, 8-v, 8-x, 9-r, 9-t, 11-s
Mains, live steam	T2	9-h, 10-n
Mains, low-pressure steam and exhaust	T4	9-n, 12-n, 13-g, 15-q, 15-s
Mains, medium-pressure process steam	T3	9-j, 9-n, 13-p
Materials Handling Equipment	R2	9-n, 12-p
Mills, coal, central	B4	11-b
Mills, coal, high-speed unit	B9	12-c
Motors, d.c.	L1	8-b
Motors, induction	L2	10-s
Motors, synchronous	L4	9-u
Motors, variable speed a.c.	L3	15-w
Motor-Generator Sets	L5	11-v
Oil, fuel and diesel	A5	14-b
Plants, adjoining industrial	I4	3-t
Power, purchased	G1	3-i
Power Transmission, bearings	M13	7-s
Power Transmission, belts	M2	7r, 7-t, 10-p
Power Transmission, chain drives	M7	9-s
Power Transmission, counter and jack shafts	M4	6-t
Power Transmission, friction clutches	M15	9-q
Power Transmission, gear speed reducers	M11	10-u
Power Transmission, geared motor reducers		

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L5—Motor-Gen

1—Check condition of
brushes and rigging,
slip-rings. Check ad
tion.

2—Check voltage at
voltages more than 1
below nameplate rat
rected.

3—Check loads. Reloca
loading.

4—Consider suitability
the application and o

5—With synchronous t
field strength to de
is of proper value.

6—Consider advisabilit
of plant load by sync
improve power factor.

7—Check suitability o
the service requiremen
they embody adequa
tures.

8—Consider advisability
controls with autom
types.

M1—Power Trans

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CHECK CHART

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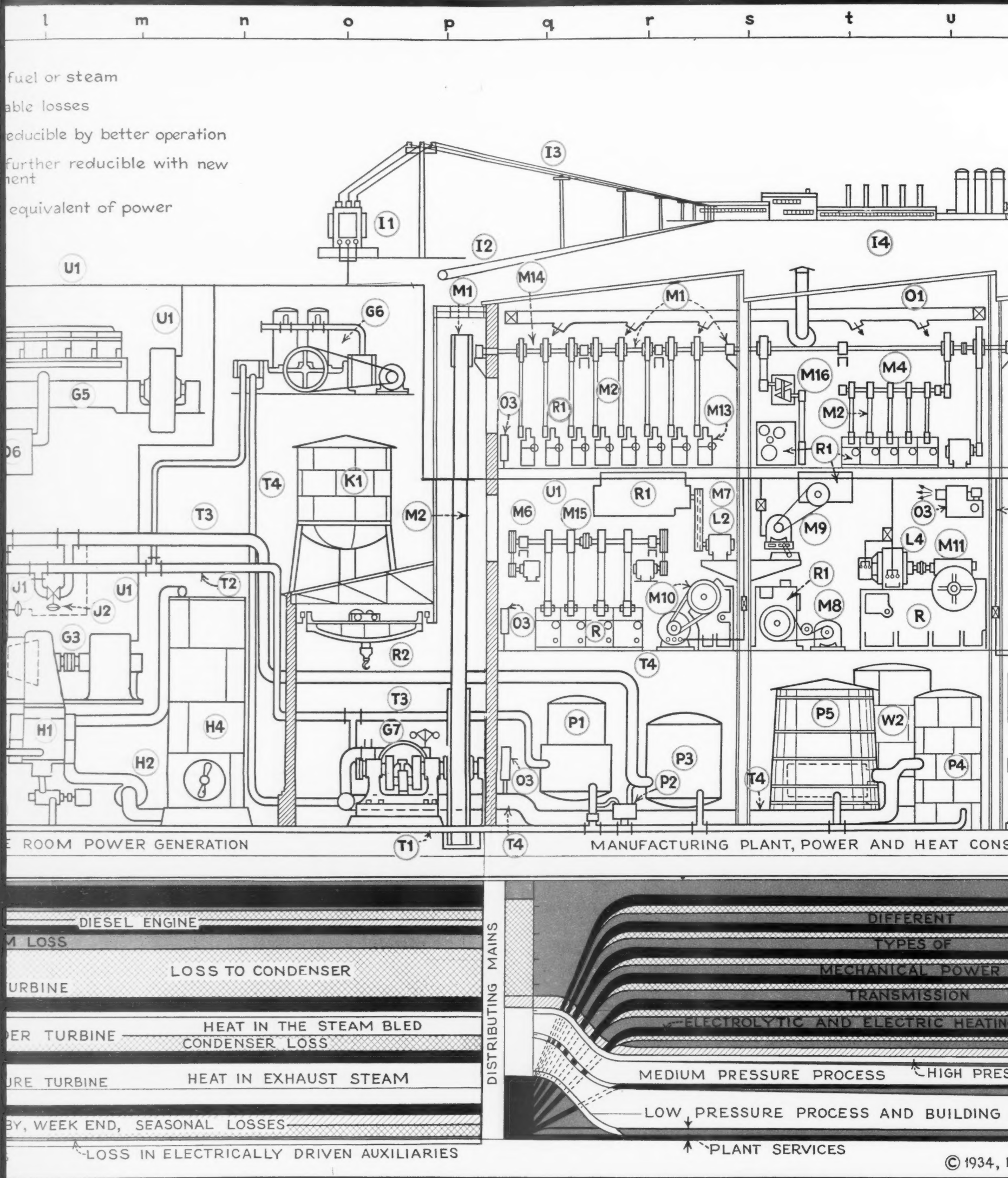

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5—Consider improvement of the plant where power is purchased and steam is used for process, by covering all steam demand by the back pressure turbine and purchasing less power. Also an old condensing plant may be improved by a superimposed high-pressure turbine and boilers.

G5—Diesel Engines and Generators

1—Schedule running in respect to other units and process steam demand.

2—Schedule methodic maintenance.

3—Check performance of the engine and fuel by frequent indicator diagrams.

4—Use light oils for starting in cold weather when engine is below 45 degrees F. or provide for hot water circulation.

5—Give three-quarters to full load when running.

6—Check clearness and temperature of exhaust; quality of cooling water.

7—Install recirculation.

8—Consider installing a diesel engine in a steam plant as a standby for night and week-end loads to reduce low load and banking losses.

9—Ditto for a case of sharply differing seasonal loads, when cooling water for a condensing steam unit is not available.

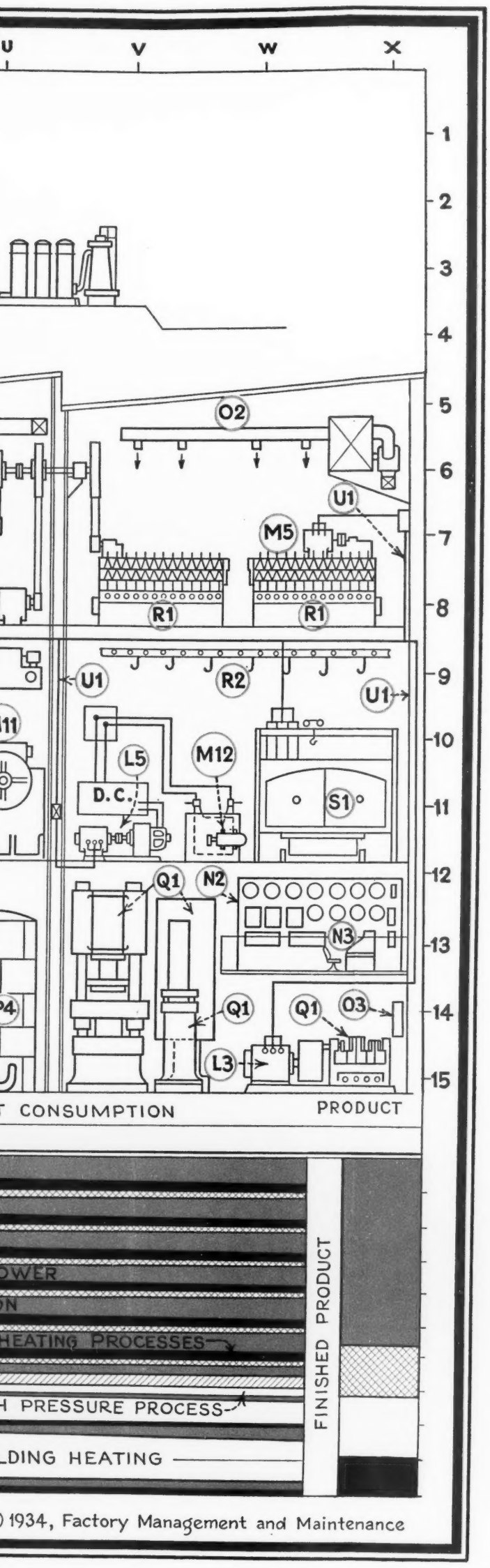
10—Install complete lubricating oil reclaiming systems.

G6—Air Compressors

KEY TO LOCATION OF EQUIPM

Part	*Symbol*	*Location*
Accumulators, hot water	W2	13-t
Accumulators, steam	W1	8-j
Air, interconnections for	I2	4-p
Air, overfire	E5	11-d
Air Conditioning	O2	5-n
Arches	D11	11-e
Ashes	A6	15-e
Ashpits	E6	12-e
Baffles	D7	7-e
Bearings	M13	7-s
Belts	M2	7-r, 7-t, 10-p
Bins, pulverized coal	B7	7-b
Blowers, soot	D10	6-e
Boilers	D1	7-e
Boilers, waste heat	D6	8-l
Bunkers, coal	B2	4-c
Burners, gas	C4	10-d
Burners, oil	C2	10-d
Burners, pulverized coal	C3	10-d
Capacitors	U2	4-j
Clutches, friction	M15	9-q
Coal, base contract	A1	2-c
Coal, spot	A2	2-e
Coal Handling Equipment	B1	2-d
Coal Yards	A3	2-f
Combustion Control, automatic	N1	11-b
Compressors, air	G6	6-o
Condensate Returns	T1	9-g, 14-h
Condensers	H1	13-i
Cooling Towers	H4	15-p
Dampers, air	D8	10-f

Part
Machines, production
Mains, live steam
Mains, low-pressure steam and exhaus
Mains, medium-pressure process steam
Materials Handling Equipment
Mills, coal, central
Mills, coal, high-speed unit
Motors, d.c.
Motors, induction
Motors, synchronous
Motors, variable speed a.c.
Motor-Generator Sets
Oil, fuel and diesel
Plants, adjoining industrial
Power, purchased
Power Transmission, bearings
Power Transmission, belts
Power Transmission, chain drives
Power Transmission, counter and jack shafts
Power Transmission, friction clutches
Power Transmission, gear speed reducers
Power Transmission, geared motor reducers
Power Transmission, group shaft 2-motor drives
Power Transmission, group-driven machines



M8—Idler Drives

1—Check adequacy of lubrication of pulley and arm.

2—Check diameter and location of pulley and pressure exerted from standpoint of belt flexing, tension on belt, and arc of contact with small pulley. Too much tension and unnecessarily severe flexing of belt result in short life and waste of power.

3—Check suitability of belt for the service.

4—Consider advisability of replacing with some other type of drive.

M9—Pivoted Motor Base Drives

1—Check belt tension to determine whether it is of proper value for the service.

2—Determine whether joining of belt or other condition causes objectionable jumping of motor.

3—Consider advisability of replacing with some other type of drive.

M10—V-Belt Drives

1—Check condition of all strands and tension on each.

2—Check pulleys for proper grooving and condition.

3—Check alignment.

4—Consider advisability of replacing with some other type of drive.

M11—Gear Speed Reducers

1—Check size and type to determine suitability for service.

2—Check alignment.

3—Check adequacy of lubrication.

4—Consider advisability of replacing with some other type of drive.

M12—Geared Motor Reducers

1—Check alignment.

2—Check adequacy of lubrication of motor bearings and gear unit.

3—Consider advisability of replacing with some other type of drive.

M13—Bearings

1—Determine condition of bearings.

2—Consider suitability of all bearings for load, speed, and operating conditions.

3—Check quality of lubrication, kind and suitability of lubricants, method and frequency of application.

4—Investigate possibility of reducing lubrication costs by change in type of bearing, lubricant, or method of application.

M14—Pulleys

1—Determine suitability of type for operating conditions.

2—Check trueness, crowning, tightness on shaft, general condition.

3—For high-speed operation, pulleys should be balanced.

M15—Friction Clutches

1—Check rating of clutch against load carried. Clutches should be rated 25 per cent higher than load.

2—Check adjustment of friction surfaces.

3—Check adequacy of lubrication.

M16—Variable Speed Transmissions

1—Check condition of power-transmitting medium and cones.

2—Check condition of bearings, and adequacy of lubrication.

3—Check condition of speed control mechanism. Consider advisability of replacing manual control with automatic or remote type.

4—In the case of hydraulic types, inspect all lines and connections for leaks. Check adequacy of lubrication.

N1—Automatic Combustion Control

1—Arrange boiler instrument boards, take out obsolete instruments, add new instruments.

2—Devise chart for checking boiler performance. Instruct watch engineers and firemen in proper understanding of combustion.

3—Consider various degrees of combustion control.

4—Consider draft, stoker, speed, balanced furnace draft, draft fan speed.

5—Use master regulator for each boiler and for groups of boilers.

N2—Automatic Plant Control (Processes)

1—In the interest of even quality of production, install complete set of pressure, temperature, and flow recorders for the steam process plant. Also for checking waste steam, power, and better planning and control of the operation.

2—Consider various degrees of centralized, remote control for the processes and the building heating, to be operated from a central board equipped with all the necessary indicating instruments.

N3—Meters and Control Instruments

1—Check instruments. Replace the obsolete, maintain all in good adjustment.

2—Devise plant operating record system for checking performance and for supplying the data for future extensions or rebuilding.

O1—Ventilation

1—Check suitability of available ventilation, accessibility of control shutters and dampers, proper use of them, and recirculation of warmed air for heat saving.

2—Check actual fan speeds vs. fan design in a central system, change motors if inadequate.

3—Check the course of inlet air and available outlets.

4—Investigate local needs of additional ventilation, shortage of which hampers labor.

5—Check humidity and adjust ventilation.

6—Survey the natural circulation of air and drafts. Install screens to protect workers from drafts.

7—Survey the processes in which harmful gases and vapors are produced. Verify actual pick-up of these emanations by the ventilating system (hoods, cowls).

2—Adjust live steam pressure reducing auxiliary valve (de-superheater).

3—Check draining and quality of steam. Install drip pockets.

4—Consider automatic control of steam pressure, also automatic turbine load distribution.

5—Insulate the apparatus.

P4—Low Pressure Process Steam

1—Check winter and summer balance of low pressure steam with power demand.

2—Schedule operation of back pressure and condensing units to reduce throttling of live steam to minimum.

3—Adjust process pressure to that of the heating system.

4—Check quality of steam, draining, pressure loss in distribution mains.

5—Sometimes boosting exhaust pressure by live steam is of advantage.

6—Usually the low pressure process apparatus is made with large radiation and other heat losses. Check draining, traps, venting of air, insulation of piping and apparatus. Consider multiple effect installations.

P5—Hot Water for Processes

1—Consider hot water process apparatus as a thermal surge tank for the plant.

2—Investigate economy of passing the hot returns through heat exchanger as well as the exhaust steam.

3—Consider heating by economizers—storage of hot water at night or during periods of low steam demand.

Q1—Hydraulic Plants

1—In selecting equipment, consider power consumption as well as production efficiency.

2—Enforce a maintenance program that will prevent power loss due to faulty packings, parts, and inadequate lubrication.

R1—Production Machines

1—Maintain correct lubrication.

2—Maintain alignment of working parts.

3—Check size of motor against power requirement (both individual and group drive) and substitute smaller motors wherever possible.

4—Keep bearings in good condition; consider advisability of changing type.

5—Do not operate with dull tools.

6—Check production layout to encompass equipment in minimum practicable area to eliminate unnecessary amount of power transmission equipment.

R2—Materials Handling Equipment

1—Check method of drive.

2—Check size of motor against load.

3—Check condition of bearings; consider advisability of changing type.

4—Check adequacy of lubrication.

5—Check alignment and supports.

6—Keep storage batteries in good condition; schedule travel of battery operated equipment to avoid idle and underloaded operation; charge batteries at proper rates and do not overcharge.

S1—Electric Furnaces and Ovens

1—Check adequacy of insulation for minimum heat loss.

2—Check uniformity of heat distribution, to reduce waste of power, and spoilage of product.

3—Install or check condition of temperature control.

4—Consider advisability of scheduling operation to take advantage of off-peak rates, or reduced-demand periods.

5—Consider advisability of time switch control, to prevent operation longer than necessary, or in on-peak periods.

T1—Condensate Returns

1—Check the waste of condensate and drips. Insulate hot condensate lines.

T2—Live Steam Mains

1—Check pressure drop to distant points, proper draining, insulation, branch disconnect valves, loss of superheat, suspension, expansion joints.

2—Consider seasonal re-distribution of steam. Install branch disconnecting valves, schedule their operation to reduce radiation losses.

3—In a large distributing system, consider new piping for tying in different sources of steam.

4—Eliminate unnecessary steam piping.

T3—Medium Pressure Process Steam Mains

1—See 1 under T2.

2—Give special attention to pressure drop to points of consumption for bleeder and back pressure turbine installations.

3—Check the minimum necessary pressure and operate at it.

T4—Low Pressure Steam Mains and Exhaust Mains

1—Check pressure drop, proper draining, pressure drop in valves.

2—Change globe to gate valves if the former are throttling steam and the exhaust is partially or entirely wasted.

U1—Electrical Distribution Systems

1—Check condition of insulation. Are all conductors adequately protected against mechanical injury?

2—Check voltage drop and load carried to determine need for larger or additional feeders, or power factor correction.

3—Determine power factor. Consider advisability of correction.

4—Check condition of permanent grounds.

5—Install, or check condition of, ground detectors.

6—Investigate adequacy of circuit protective devices used.

7—See also item G1.

U2—Capacitors

1—Determine advisability of adding more

IPMENT

	Symbol	Location
.....	R1	8-q, 8-s, 8-t, 8-v, 8-x, 9-r, 9-t, 11-s
.....	T2	9-h, 10-n
d exhaust	T4	9-n, 12-n, 13-g, 15-q, 15-s
ess steam	T3	9-j, 9-n, 13-p
nt.....	R2	9-n, 12-p
.....	B4	11-b
.....	B9	12-c
.....	L1	8-b
.....	L2	10-s
.....	L4	9-u
.....	L3	15-w
.....	L5	11-v
.....	A5	14-b
.....	I4	3-t
.....	G1	3-i
s.....	M13	7-s
.....	M2	7r, 7-t, 10-p
rives....	M7	9-s
and jack		
.....	M4	6-t
clutches	M15	9-q
ed re-		
.....	M11	10-u
notor		
.....	M12	12-w
haft 2-		
.....	M6	9-q
riven		
.....	M3	9-q

L5—Motor-Generator Sets

1—Check condition of windings, bearings, brushes and rigging, commutator or slip-rings. Check adequacy of lubrication.

2—Check voltage at motor. In general, voltages more than 10 per cent above or below nameplate rating should be corrected.

3—Check loads. Relocate to secure proper loading.

4—Consider suitability of each motor for the application and operating conditions.

5—With synchronous type, check load and field strength to determine whether it is of proper value.

6—Consider advisability of carrying part of plant load by synchronous motors, to improve power factor.

7—Check suitability of controls used for the service requirements. Make sure that they embody adequate protective features.

8—Consider advisability of replacing manual controls with automatic or magnetic types.

M1—Power Transmission Shafts

1—Check alignment.

2—Check for excessive twisting or bending, indications of overload, or inadequate

1—Check capacity, provisions for spontaneous fire localization, vents, drainage if coal is stored under water.

B3—Coal Weighing Lorries

1—Periodically check the balance and coal car weights. Compare R.R. weights with your own. Install lorry if charging of hoppers requires excessive labor. Weigh all coal.

B4—Coal Mills (Central)

1—Consider pulverized coal firing to increase boiler capacity and to be freer in selection of coal. Are stokers worn out? Is a variety of coals available?
2—Select mill according to grindability of available coals. Replace old mills to save maintenance.
3—Install automatic mill control.
4—Check performance of mill parts, select more serviceable materials for parts where necessary.
5—Check steam consumption of coal dryer and consider use of flue gas.
6—Discard dryer, install heater for air to mills.
7—Control air temperature.
8—In a central (bin and feeder) system schedule mill operation for off-peak periods.

B5 and B6—Cyclone Separators and Pulverized Coal Pumps

1—Determine cyclone efficiency and coal pump adequacy. Check wear of parts.
2—Check distributing valves.
3—Install cyclone ahead of mill exhauster suction.

B7—Pulverized Coal Bins

1—Provide adequate capacity for scheduled operation.
2—Clean out bins periodically for fire prevention.
3—Check ground coal moisture.
4—Install coal level measuring devices, and steam lines to blanket fires.
5—Insulate outside bins to avoid sweating and bridging.
6—Install bin vent washers or filters.
7—Install vacuum cleaning system for the whole coal preparation plant.

B8—Mill Exhausters

1—Check the wear; try different metals, hard-facing, welding.
2—Check air handled.
3—Relocate the exhauster if connected ahead of cyclone.

B9—High-Speed Unit Mill

1—Consider unit mills for small and medium-sized boilers.
2—Select type according to grindability of coal.
3—Adjust mill air, install control and magnetic separator.
4—Check for uniformity in action of feeder; fineness of grinding; speed and power.
5—Consider air heater for mill drying of coal.
6—Check wear of parts, consider different materials, hard-facing, welding.

B10—Coal Hoppers

1—Check capacity; build it up not to require too frequent filling.
2—Install agitator shaft for breaking bridging.
3—Use swinging, non-segregating chutes for more even fuel bed.

B11—Oil Fuel Pumps

1—Check fuel oil pressure for proper atomization in mechanical burners.
2—Check proper steam pressure for others.

B12—Fuel Oil Heaters

1—Determine and maintain proper temperature of oil for best atomization, especially at low ratings.

B13—Coal Dryers

1—Check steam consumption of coal dryer and consider use of flue gas.
2—Discard dryer, install heater for air to mills.

B14—Pulverized Coal Feeders

1—Check uniformity of action and wear.
2—Control temperature of primary air.
3—Check feeder motor speeds.
4—Install interlocking device with draft fans.
5—Feeders must always be in first-rate condition.

renovation of furnaces.
2—Check adequacy of air ports and of flow of secondary air in air-cooled furnace walls.

C4—Gas Burners
(Natural or Blast Furnace Gas)

1—Adjust air to burners for greatest turbulence and shortest flame, to avoid stratification and unburned-gas loss.

D1—Boilers
(Drum)

1—Install throttling calorimeter, check quality of saturated steam. Schedule water level vs. load, to keep moisture in steam low. Check steam separating baffles, dry pipe. In serious cases consider steam separators or purifiers. Install high and low water alarms, calorimeter temperature recorder.
2—Investigate your critical hydroxyl content (maximum concentration of salts) and maintain below the value found to eliminate sharp rise of wetness in steam.
3—In horizontal return tubular boilers use water level to pass sharp peaks.

(Blowdown)

1—Check blowdown connections, whether they drain places with maximum concentration.
2—For continuous blowdown arrange multiple drains, connect to manifolds.
3—Install improved blowoff valves. (See also 3 under F2.)

(Boiler)

1—Keep minimum of boilers on the line properly loaded. Schedule operation and outage to bring banking and low dead losses to minimum.
2—Cover fluctuating load by a part of boilers (if constant load is small, then better boilers should carry fluctuations).
3—Test boilers and determine best operating load ranges for each.
4—Wash, sandblast outside of heating surface.
5—Use protective coatings inside the drum and on steam separating baffles; also airtight coating on outside surface of boiler setting.
6—Raise the boiler if setting is obsolete.
7—Change baffling to fewer passes to increase capacity or to more passes to increase efficiency depending on available fuel bed surface or draft.
8—Consider remodeling the boilers by adding economizers, air heaters, stokers, pulverized coal firing, improved furnaces, water walls, water backs.
9—If steam pressure is too low for some new apparatus, consider independent high-pressure elements for the old boilers in the same setting and a demand balancing reducing valve for the old mains.
10—Consider new boilers for the plant, one or a few large boilers to supplant several small old boilers.
11—In general, consider new set-ups for power and process steam utilization, future plant extensions and processes, schedules of operation.
12—Consider increased steam pressure, even if, temporarily, new boilers should run at old pressure.
13—Consider new fuel or method of firing. The process of designing a new boiler plant requires time and careful gathering of operating data. This should be kept in mind and data prepared long before the preliminary action on reconstruction is started.
14—In designing a new boiler plant do not cripple the design by trying to keep too much of the old equipment. If the old plant is still valuable as a reserve, put the new plant in a new location with provisions for future extension and ultimate scrapping of the old plant.
15—The successful operation of a new boiler plant depends on so many factors of design that expert judgment should be obtained.

D2—Superheaters

1—Use highest superheat within economical limits the engine and steam equipment will stand.
2—Check causes of insufficient or excessive superheat.
3—Change baffling to obtain results.
4—Weed out a few boiler tubes to get hotter gas to superheater.
5—Check even distribution of steam among tubes, use orifice plugs for correction.
6—Check lighting, shutting down, and banking operations if radiant superheaters are used, which suffer most in these conditions.
7—Consider a slight superheat in a saturated steam plant with long outdoor distribution; separately fired superheater may be most economical.
8—Install superheaters after checking valve and piping materials.

steam. (Superheater may pay in lesser water rates and lesser maintenance.)
10—Check quality of exhaust steam if used for process (the latter usually improves with dry exhaust steam).
11—If your superheat is inadequate, especially at low loads, consider adding radiant superheating surface, which will also protect furnace walls.
12—Check the action of soot blowers on superheaters, schedule more often than for other parts.

D3—Economizers

1—Schedule washing and sand blasting of economizer surface.
2—Check leakage of air at boiler joints.
3—Repair water leaks immediately to avoid sulphuric corrosion.
4—Avoid low gas temperature (below dew point); recirculate some gas at low ratings or banking.
5—Avoid using water at less than 180 deg. F. to reduce pitting.
6—Catch the moment when economizer needs retubing for putting in a new one with higher water velocities of improved type.
7—Consider installing economizer to improve efficiency, and to increase steaming capacity. Verify draft available; if not sufficient, consider revamping of firing equipment—to get maximum capacity with increased draft.
8—Consider a single economizer for a battery of boilers; connect to it gas from plant furnaces, diesel exhaust, and other sources of waste heat.

D4—Air Heaters

1—Check air leakage at joints.
2—Schedule soot blowing.
3—Watch dew point in gas; recirculate flue gas; by-pass some air in severe cold.
4—Check whether all possible air goes to heater.
5—Consider installing air heater for oil and pulverized coal firing to improve efficiency and steaming capacity. Resulting higher furnace temperatures improve combustion but may increase wear of furnace refractories.
6—For stoker firing do not raise air temperature above 300 deg. F. to avoid high maintenance of stoker parts.
7—Consider a single air heater for a battery of boilers, using in it other sources of waste heat. Count benefits of new draft installation which will increase steaming capacity.
8—Consider diversion of hot air to coal mills for drying and for improving air heater performance.

D5—Water Walls

1—Increase boiler capacity by adding water walls in the furnace.
2—Protect brickwork by water-cooled tubes or steam superheating tubes.
3—Check brickwork maintenance against cost of water walls.
4—Reduce slagging of boiler tubes by lowering furnace temperature with water walls.
5—Consider air-cooled walls for coals of poor ignition characteristic.

D6—Waste Heat Boilers

1—Consider waste heat boiler or water heater with the diesel engine. Check the possibility of using the jacket cooling water.
2—Consider boilers using waste heat from furnace processes.
3—Check dust content in gas, install proper dust handling and blowing system.
4—The boiler may be advantageously assisted by oil or pulverized coal burners.
5—Improve the furnace processes to reduce heat loss before considering waste heat boilers.

D7—Baffles

1—Inspect and keep baffles tight.
2—Investigate draft loss and dead pockets produced by baffles and if necessary modify the baffling.

D8—Air Dampers

1—Check average control of air by firemen.
2—Adjust automatic draft control. Verify absolutely necessary excess air.
3—Install CO_2 indicator or combustion meter.
4—Check air leaks into furnace.

D9—Gas Dampers

1—Check average control by firemen.
2—Adjust automatic control.
3—Adjust furnace draft to slight negative under boiler tubes.

HOW T

THERE are two principal Check Chart: (1) an Inc (2) a Graph. Both are arra divisions, as will become ap tion and upon reading the

The graph applies to a con variety of steam and power p and consuming facilities de ordinary types. It is not quan every plant is comprised o diagram, and a similar graph constructed to represent the any given plant, from which can be made.

As shown, the graph is i energy input and output of consuming unit as contained energy, whether electrical or the efficiencies and losses fro through the numerous steps tributions, transformations, a end result of the heat or ene quired by the factory produc

Generation o

The total height of the gra heat in the fuel plus the therm purchased. Satisfied power mands are indicated by appr

Consider generated power the solid red stream of unav is shown. It will vary with t fuel. To this loss may be inherent loss due to unburn

Before the fuel is fired, tank, leakage, wind, and v added. When the fuel is fire recovered by the boiler and in the form of steam, shown

Below the zero line of the returned to the system. By p nace losses from the hydroge the effect upon efficiency (economizer, air heater) can losses require correction.

In the text, under headings letter and number symbols sh suggestions and reminders ar heavy slagging and loss in un remedied by cooling the furn as suggested under D5. T stratified flow of gas, and CO by overfire air (see E4 and water troubles read F1 and F2 cerning investigations to be

4—Install rudimentary control for han fired furnaces.
5—Provide explosion doors for oil and p verized coal firing.

D10—Soot Blowers

1—Check steam consumption vs. increas boiler efficiency, and schedule operati
2—Check actual effect of soot blowi also whether there is tube cutting steam jets.
3—Check adequacy of number and rig position of soot blowers.

D11—Arches

1—Check the sufficiency of arch elevatio their shape for better re-radiation a less erosion.
2—Relocate arches. For anthracite co go to the long rear arch firing with circulation of ignited coal over the f bed.
3—Select the proper negative margin draft in the furnace and maintain it save brickwork.
4—Install balance draft control.

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TO USE THE CHECK CHART

rincipal parts to the Power Loss
) an Industrial Plant Diagram;
are arranged with certain sub-
come apparent upon examina-
ing the following paragraphs.

to a complex plant with a wide
power purchasing, generating,
ilities designed to include all
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raph is illustrative of heat and
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contained in the fuel, steam, and
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f the graph represents the total
the thermal equivalent of power
d power and process steam de-
l by appropriate ordinates.

ed power. Starting at the left,
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ry with the composition of the
may be added the minimum
unburned carbon in the ash.

s fired, the coal yard, sludge
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uel is fired, all heat is lost until
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hydrogen-loss red line down,
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headings that correspond to the
mbols shown on the diagram,
inders are given. For example,
oss in unburned carbon may be
the furnace with water walls,
D5. The smoke nuisance,
, and CO loss can be remedied
E4 and E5). In case of feed
F1 and F2 for suggestions con-
ns to be made.

Engine Room

Total heat in steam enters the engine room and a large part of it is shown as consumed by turbo-generators. Note the loss of power in the electrically driven auxiliaries. The illustrated plant may be well run; but, for example, insufficient steam pressure may necessitate running the condensing unit and purchasing power. The condenser loss is cross-hatched in red, meaning that if a new high-pressure boiler and bleeder or back-pressure turbine were installed, a greater amount of power could be generated or the steam exhausted into process mains, and either the purchasing of power or the condensing operation might be eliminated.

The bleeder turbine condenser loss indicates conditions of operation when the process steam demand does not parallel the power demand during the fluctuations.

On the diesel-engine level the single and cross-hatched red streams indicate that part of the heat is recoverable by better loading schedule and part by installing waste heat equipment (see D6 and G5).

Shop

At the shop wall the vertical section of the graph shows the summarized power and steam delivered by the electric and steam mains to the various shops. The reduction of power losses in this department depends upon betterment of equipment and operation.

Through the shops the power streams are shown dwindling due to the losses. So are the white streams of process and heating steam. The power and heat actually taken up by the formation of the finished product are shown on the extreme right. Shop loss is indicated by the differences in the areas making up the left and right vertical sections which show the power and heat delivered to the shops and the power and heat residing in the final product. Thus the manufacturing thermal efficiency of the total plant is the ratio of power and heat in the final product to the total heat supplied (ordinates).

Standby Losses

Attention is called to the red streams below the engine room, representing standby, week-end, and seasonal losses. In many cases these losses may amount to a considerable fraction of the total heat. One of the remedies is found in the diesel engine (see G5), another in purchased power (see G1).

It is advisable to prepare graphs of a normal week's duration and, in case of seasonal operation, for the duration of several typical weeks.

In a study of any existing plant a survey of apparatus shown on the diagram may suggest physical improvements that can result in very attractive savings.

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5—Check explosion doors in boilers fired with gas, oil, pulverized coal.

E1—Fans, Forced Draft

1—Verify draft sufficiency.
2—Check resistances in ducts.
3—Install a blower to increase boiler capacity; consider whether steam or electric drive will be best suited.
4—For large installations consider changing the forced draft fans and drive. (Electric for summer season, steam for winter may bring economies).
5—Consider variable speed vs. damper control.

E2—Fans, Induced Draft

1—Verify whether lack of draft limits steaming capacity; check draft loss in ducts.
2—When considering new fan, make allowance for draft loss in a future dust catcher.
3—Check paths of cinder erosion in high-speed fans; apply hard-facing, or weld protector plates to vanes. If dust catcher is installed, relocate fan to follow dust catcher.
4—Consider variable-speed vs. damper control of draft.
5—Arrange some fans for electric drive in summer season when exhaust steam use is limited.

E3—Fans, Primary Air

1—Control air pressure in primary fan to insure proper coal transfer to burners at all loads with no deposits in the feeder lines.
2—Arrange connection to bottom of coal bin, with valve for breaking bridging.
3—Control temperature of primary air.

E4—Stacks

1—Check condition; clean cinder accumulations from ducts and stack base; check draft; check complaints on cinder and dust nuisance.
2—Analyze gas periodically or install CO_2 recorder; for oil and natural gas firing install unburned gas detectors.
3—Check fly ash and cinders in gas; schedule cleaning of boiler cinder pockets.

ash; if high, return to furnace.
5—Consider a new stack, plain or in combination with cinder-catching equipment; consider brick lining for gas high in sulphur oxides.
6—Consider washing gas in the stack, lead- or tile-lined water pan, neutralization of sulphuric water by lime.

E5—Overfire Air

1—Consider jets of air above fuel bed for turbulence, better mixing of stratified volatile, and its better combustion.
2—Overfire air may help to cool arch tips and reduce flame erosion.
3—Determine the best amount of overfire air, especially for high-volatile coals.

E6—Ashpits

1—Consider clinker grinders vs. dump plates for stokers, or adjustable water back for chain grate stokers.
2—Schedule clinker grinder operation.
3—Install slag screen or water-cooled ash hopper in boilers converted to pulverized coal.
4—Consider possibility of a slag tap furnace if melting point of ash is too low.

E7—Induced Draft Fan Turbines
(Also Other Steam Auxiliaries)

1—Collect all the exhaust into open heater even if it requires long lines, and drain closed heater into it.
2—Control diversion of warm condensate from processes to the open heater to maintain proper de-aeration.

F1—Feed Water Filters

1—Check suspended solids in feed water, inherent and occasional.
2—Install filters.
3—Filter condensate from old lines.

F2—Feed Water Treatment Plants

1—Stop experimenting yourself, get your water analyzed by experts, and obtain prescribed treatment by authorities in this field. Do not take chances on burned tubes, corrosion, embrittlement. Avoid patented panaceas.
2—Maintain careful control, analyze often. Obtain apparatus for quick analysis. Repeat same with boiler water. Install sampling apparatus. Maintain recommended sulphate-carbonate ratio.
3—Schedule and measure blowdown. Install surface blowdown when priming begins to bother. Install heat reclaiming continuous blowdown system when warranted.
4—Investigate sources of better feed water, sources of contamination (oil coolers, heaters, cross connections with raw water).
5—Analyze for dissolved oxygen. Improve de-aeration and check its functioning. Install de-aerating heaters.
6—Install feed water treating equipment, but only after expert analysis of the whole problem by specialists. Consider feed water treatment vs. extended recovery of all uncontaminated condensate.

F3—Open Heaters

1—Check water temperature rise. Arrange controlled bleeding or throttling of live steam to achieve de-aeration. Verify proper flow of water on trays, draining of floating scum and oil, blowdown of sediment. Return all drips and drains to open heater.
2—Consider recirculation of water through steam space for increasing open heater's capacity and efficiency.
3—Verify complete de-aeration of feed water, freedom from oil and suspended solids.
4—Maintain steam pressure slightly under relief valve setting.
5—Arrange control of load distribution among the units so that the relief valve does not open and the loss through air vent is tolerable.
6—Admit make-up water to the heater.

F4—Boiler Feed Pump

1—Check water pressure at all loads.
2—Install pressure regulator and check feed valve operation; install automatic feed valves to reduce power or steam consumption.
3—Check maximum feed capacity.
4—Weigh a centrifugal vs. reciprocating pump when new one is needed.
5—Check feed system for reliability and continuity of feed supply.
6—Check whether a change of drive would be economical, especially when seasonal conditions control steam consumption.

F5—Closed Heaters

1—Check terminal temperature proper air venting, disposition condensate, pressure drop of ste
2—Consider installing a high pres heater in the absence of eco impossibility of using the latte in case of bleeder or high ba turbines.
3—Consider a low pressure cl before the open heater if t steam flow is uneven, when s steam auxiliaries are short o a lower back pressure would h their capacity.

F6—Open Heater Relief

1—Check relief pressure. Ba among condensing and bac units so that no steam is wa feed water temperature is re de-aeration is assured.
2—Consider the system's steam balance for summer and winte and, if the wastage of stea investigate the economies condensing units or installing

G1—Purchased Pow

1—Study contracts carefully schedule load to avoid high pe Consider demand limitatio power factor; if low, improv stalling synchronous motor densers.
2—Consider further electrificat esses and auxiliaries to reac rate brackets.
3—Consider processes or elec for using cheap night or d power if such is available. Co purchased power for night an loads to reduce the expense of connection and night operat plant.
4—If plant is large, investigat of tying up with public utility operation.
5—Investigate possibility of gro neighbor plant to buy larger power if sufficient diversity fac
6—Check losses between trans switchboard.

G2—Condensing Turbo-G

1—For several turbo sets sched operate closer to best points.
2—Verify relative water rates flow meters, because they blade wear and actual con formance.
3—Consider increasing size of outside fan cooling of the ge overload steam valves to increa Install thermocouples in gene ings.
4—If heating and process ste let the condensing unit carry tuations, but check whether sure units are adjusted to ca before main line throttles i mains.
5—Consider replacement of giving exhaust steam in exces ments, by condensing turbi tendant saving in space, fuel, simultaneous change in boile a chance to raise steam pressu perature to effect further
6—In plant extensions with con bines, weigh delivery of circu vs. cooling tower or vice vers cation of power house.

G3—Bleeder Turbo-Ge

1—Schedule operation to cove of process or heating steam d that supplied by back pre Check control of bleed pressu
2—Consider installation of a bine in cases of seasonal ste or a sharply variable ratio steam demand, or when a ne quires medium steam pressu from other exhaust.
3—Bleeder and back pressure tu tion can be greatly improved a steam accumulator or t process steam line. In case fluctuating steam demand, lator will steady the boile

G4—High Back Pressur Generators

1—Schedule loading for a m loss in condensing and bleed
2—Cover base demand for p letting bleeder unit cover flu steam and power demand pressure control.
3—Install automatic regulati tribution.
4—Install parallel control wit reducing valve if load is n steady. Install superheate valve.

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4—Install dust catchers; check carbon in fly ash; if high, return to furnace.

5—Consider a new stack, plain or in combination with cinder-catching equipment; consider brick lining for gas high in sulphur oxides.

6—Consider washing gas in the stack, lead- or tile-lined water pan, neutralization of sulphuric water by lime.

E5—Overfire Air

1—Consider jets of air above fuel bed for turbulence, better mixing of stratified volatile, and its better combustion.

2—Overfire air may help to cool arch tips and reduce flame erosion.

3—Determine the best amount of overfire air, especially for high-volatile coals.

E6—Ashpits

1—Consider clinker grinders vs. dump plates for stokers, or adjustable water back for chain grate stokers.

2—Schedule clinker grinder operation.

3—Install slag screen or water-cooled ash hopper in boilers converted to pulverized coal.

4—Consider possibility of a slag tap furnace if melting point of ash is too low.

E7—Induced Draft Fan Turbines
(Also Other Steam Auxiliaries)

1—Collect all the exhaust into open heater even if it requires long lines, and drain closed heater into it.

2—Control diversion of warm condensate from processes to the open heater to maintain proper de-aeration.

F1—Feed Water Filters

1—Check suspended solids in feed water, inherent and occasional.

2—Install filters.

3—Filter condensate from old lines.

F2—Feed Water Treatment Plants

1—Stop experimenting yourself, get your water analyzed by experts, and obtain prescribed treatment by authorities in this field. Do not take chances on burned tubes, corrosion, embrittlement. Avoid patented panaceas.

2—Maintain careful control, analyze often. Obtain apparatus for quick analysis. Repeat same with boiler water. Install sampling apparatus. Maintain recommended sulphate-carbonate ratio.

3—Schedule and measure blowdown. Install surface blowdown when priming begins to bother. Install heat reclaiming continuous blowdown system when warranted.

4—Investigate sources of better feed water, sources of contamination (oil coolers, heaters, cross connections with raw water).

5—Analyze for dissolved oxygen. Improve de-aeration and check its functioning. Install de-aerating heaters.

6—Install feed water treating equipment, but only after expert analysis of the whole problem by specialists. Consider feed water treatment vs. extended recovery of all uncontaminated condensate.

F3—Open Heaters

1—Check water temperature rise. Arrange controlled bleeding or throttling of live steam to achieve de-aeration. Verify proper flow of water on trays, draining of floating scum and oil, blowdown of sediment. Return all drips and drains to open heater.

2—Consider recirculation of water through steam space for increasing open heater's capacity and efficiency.

3—Verify complete de-aeration of feed water, freedom from oil and suspended solids.

4—Maintain steam pressure slightly under relief valve setting.

5—Arrange control of load distribution among the units so that the relief valve does not open and the loss through air vent is tolerable.

6—Admit make-up water to the heater.

F4—Boiler Feed Pump

1—Check water pressure at all loads.

2—Install pressure regulator and check feed valve operation; install automatic feed valves to reduce power or steam consumption.

3—Check maximum feed capacity.

4—Weigh a centrifugal vs. reciprocating pump when new one is needed.

5—Check feed system for reliability and continuity of feed supply.

6—Check whether a change of drive would be economical, especially when seasonal conditions control steam consumption.

F5—Closed Heaters

1—Check terminal temperature difference, proper air venting, disposition of heater's condensate, pressure drop of steam supply.

2—Consider installing a high pressure closed heater in the absence of economizers or impossibility of using the latter, especially in case of bleeder or high back pressure turbines.

3—Consider a low pressure closed heater before the open heater if the exhaust steam flow is uneven, when some of the steam auxiliaries are short of power and a lower back pressure would help increase their capacity.

F6—Open Heater Relief Valves

1—Check relief pressure. Balance load among condensing and back pressure units so that no steam is wasted, proper feed water temperature is reached, and de-aeration is assured.

2—Consider the system's steam and power balance for summer and winter conditions and, if the wastage of steam is great, investigate the economies of extending condensing units or installing oil engines.

G1—Purchased Power

1—Study contracts carefully. Try to schedule load to avoid high peak demands. Consider demand limitation. Watch power factor; if low, improve it by installing synchronous motors or condensers.

2—Consider further electrification of processes and auxiliaries to reach into lower rate brackets.

3—Consider processes or electric boilers for using cheap night or dump hydro power if such is available. Consider using purchased power for night and week-end loads to reduce the expense of breakdown connection and night operation of own plant.

4—If plant is large, investigate possibility of tying up with public utility for common operation.

5—Investigate possibility of grouping with neighbor plant to buy larger amounts of power if sufficient diversity factor obtains.

6—Check losses between transformer and switchboard.

G2—Condensing Turbo-Generators

1—For several turbo sets schedule load to operate closer to best points.

2—Verify relative water rates by steam flow meters, because they depend on blade wear and actual condenser performance.

3—Consider increasing size of nozzles and outside fan cooling of the generator and overload steam valves to increase capacity. Install thermocouples in generator windings.

4—If heating and process steam is used, let the condensing unit carry load fluctuations, but check whether back pressure units are adjusted to carry full load before main line throttles into heating mains.

5—Consider replacement of old engines, giving exhaust steam in excess of requirements, by condensing turbines with attendant saving in space, fuel, and oil. A simultaneous change in boilers may give a chance to raise steam pressure and temperature to effect further economies.

6—In plant extensions with condensing turbines, weigh delivery of circulating water vs. cooling tower or vice versa with relocation of power house.

G3—Bleeder Turbo-Generators

1—Schedule operation to cover maximum of process or heating steam demand over that supplied by back pressure units. Check control of bleed pressure.

2—Consider installation of a bleeder turbine in cases of seasonal steam demand, or a sharply variable ratio of power to steam demand, or when a new process requires medium steam pressure different from other exhaust.

3—Bleeder and back pressure turbine operation can be greatly improved by installing a steam accumulator or tank on the process steam line. In cases of sharply fluctuating steam demand, an accumulator will steady the boiler operation.

G4—High Back Pressure Turbo-Generators

1—Schedule loading for a minimum heat loss in condensing and bleeder units.

2—Cover base demand for process steam, letting bleeder unit cover fluctuations in steam and power demand under bleed pressure control.

3—Install automatic regulation load distribution.

4—Install parallel control with the pressure reducing valve if load is not sufficiently steady. Install superheater after this valve.

5—Consider improvement of the plant where power is purchased and steam is used for process, by covering all steam demand by the back pressure turbine and purchasing less power. Also an old condensing plant may be improved by a superimposed high-pressure turbine and boilers.

G5—Diesel Engines and Generators

1—Schedule running in respect to other units and process steam demand.

2—Schedule methodic maintenance.

3—Check performance of the engine and fuel by frequent indicator diagrams.

4—Use light oils for starting in cold weather when engine is below 45 degrees F. or provide for hot water circulation.

5—Give three-quarters to full load when running.

6—Check clearness and temperature of exhaust; quality of cooling water.

7—Install recirculation.

8—Consider installing a diesel engine in a steam plant as a standby for night and week-end loads to reduce low load and banking losses.

9—Ditto for a case of sharply differing seasonal loads, when cooling water for a condensing steam unit is not available.

10—Install complete lubricating oil reclaiming systems.

G6—Air Compressors

1—Schedule operation of steam and electric driven compressors for the least loss of heat in the plant. Check indicator performance. Install air filters. Arrange inlet to draw dry air.

2—Have sufficient receiver capacity for smooth operation. Maintain tight lines. Provide disconnecting valves on large branches to prevent leakage when branches are not used.

3—Consider a centrifugal compressor for larger capacities.

G7—Steam Engines

1—Check valves and steam consumption in respect to other prime movers.

2—Schedule operation for a minimum heat loss in atmospheric exhaust or condensers.

3—Use minimum cylinder lubrication.

4—In case of large engines, watch for the pulsations in the steam mains which may have unexpected forms of vibration.

H1—Condensers

1—Schedule cleaning of condensers. Check air leakage through glands, condenser joints, atmospheric relief valve pump glands. Check circulating water leakage into condenser; install condensate conductivity meter.

2—Take circulating pump suction well below water level to prevent entrainment of air. Select better tube material for bad water. Test by water hammer condenser tubes before partial retubing to eliminate weak tubes.

3—Chlorinate circulating water to reduce slime and growths. Use zinc plate in inlet boxes to reduce corrosion. Use flaring inlets to tubes to reduce inlet erosion.

4—Check steam pressure loss through condenser bank, take out some tubes to give laned, deeper steam penetration into the bank. Check tightness of air cooling zone baffle to prevent by-passing of steam into air pump.

H2—Circulating Pumps

1—Check temperature rise in circulating water.

2—Reduce capacity in winter. Adjust capacity to load if pump is large.

3—Consider two-speed motors, if electric driven. Recirculate water to reduce ice blocking.

H3—Air Pumps

1—Check over-all performance by temperature difference between inlet mixture of air vapor and saturation vapor at inlet pressure vs. water.

2—Install steam or water air ejectors instead of reciprocating pump to improve vacum and pick up heat by circulating condensate in ejector condenser beside the raw water.

3—Check draining of inter- and after-condensers, and wear of steam nozzles.

4—In bad cases of air leakage or poor condenser design, consider outside air-vapor cooler with finned tubes set before the air pump.

5—Draw more air from the hot end of the condenser.

H4—Cooling Towers

1—Check filling and distribution of water.

2—Consider installing forced draft; check outlet air humidity.

KEY TO

Part

Accumulators, hot water
Accumulators, steam
Air, interconnections for
Air, overfire
Air Conditioning
Arches
Ashes
Ashpits

Baffles
Bearings
Belts
Bins, pulverized coal
Blowers, soot
Boilers
Boilers, waste heat
Bunkers, coal
Burners, gas
Burners, oil
Burners, pulverized coal

Capacitors
Clutches, friction
Coal, base contract
Coal, spot
Coal Handling Equipment
Coal Yards
Combustion Control, automatic
Compressors, air
Condensate Returns
Condensers
Cooling Towers

Dampers, air
Dampers, gas
Distribution System, electric
Drives, see Power Transmissio
Drives, chain
Drives, group
Drives, idler
Drives, individual
Drives, pivoted motor base
Drives, V-belt
Dryers, coal

Economizers
Engines, diesel, and generators
Engines, steam
Exhausters, coal mill

Fans, forced draft
Fans, induced draft
Fans, primary air
Feeders, pulverized coal
Feed Water Treatment Plants
Filters, feed water
Flash Tanks, high-pressure con
Fuel, base contract coal
Fuel, combustible refuse
Fuel, diesel oil
Fuel, spot coal
Fuel Oil
Furnaces, electric

Gas, interconnections for
Generators, diesel engines and
Generators, Turbo-, bleeder
Generators, Turbo-, condensin
Generators, Turbo-, high back

Heaters, air
Heaters, closed
Heaters, fuel oil
Heaters, open
Heating, plant

Hoppers, coal
Hydraulic Plants

Instruments, metering and cont
Interconnections, adjoining pl
Interconnections, steam, gas, ai
Interconnections, transformer
Interconnections, transmission

Lighting (not illustrated)
Lorries, coal weighing
Lubrication (not illustrated)

3—Consider installing a cooling towe
stead of the spray pond for better vac

I1—Interconnection Transform

1—Consider possibility of interconne
with some industrial plant. The dive
factor, hourly and seasonal, may
favorable conditions for realizing m
benefits with a small capacity tie

I2—Interconnections for Stea and Gas

1—Interconnection may be for steam,
bustible gas, compressed air, water.

I3—Interconnection Transmiss Line

1—Interconnection transmission line
length and cost of right of way limi
benefits of interconnection, but the e
transmitted may cost less than p
purchased on public utility contr

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TO LOCATION OF EQUIPMENT

	Symbol	Location
ater	W2	13-t
	W1	8-j
for	I2	4-p
	E5	11-d
	O2	5-n
	D11	11-e
	A6	15-e
	E6	12-e
	D7	7-e
	M13	7-s
	M2	7-r, 7-t, 10-p
	B7	7-b
	D10	6-e
	D1	7-e
	D6	8-l
	B2	4-c
	C4	10-d
	C2	10-d
oal	C3	10-d
	U2	4-j
	M15	9-q
	A1	2-c
	A2	2-e
oment	B1	2-d
	A3	2-f
, automatic	N1	11-b
	G6	6-o
	T1	9-g, 14-h
	H1	13-i
	H4	15-p
	D8	10-f
	D9	6-d
electric	U1	4-i
ransmission		
	M7	9-s
	M3, M6	9-q
	M8	11-t
	M5	7-n
r base	M9	9-s
	M10	11-s
	B13	4-c
	D3	4-e
generators	G5	7-l
	G7	13-o
	B8	11-a
	E1	5-f
	E2	11-g
	E3	9-b
oal	B14	8-b
t Plants	F2	14-g
	F1	14-f
essure condensate	P2	15-r
al	A1	2-c
use	A4	4-a
	A5	14-b
	A2	2-e
	A5	14-b
	S1	11-x
for	I2	4-p
gines and	G5	7-l
bleeder	G3	12-m
condensing	G2	11-j
igh back pressure	G4	6-j
	D4	6-g
	F5	12-h
	B12	15-d
	F3	13-h
	O3	8-q, 9-u, 11-q, 14-q, 14-x
	B10	11-d
	Q1	13-v, 13-w, 14-v, 14-x
and control	N3	13-x
oining plants	I4	3-t
m, gas, air	I2	4-p
sformer	I1	3-o
smission lines	I3	2-q
ted)	X2	
	B3	7-c
rated)	X1	

Part	Symbol	Location
Machines, production	R1	8-q, 8-s, 8-t, 8-v, 8-x, 9-r, 9-t, 11-s
Mains, live steam	T2	9-h, 10-n
Mains, low-pressure steam and exhaust	T4	9-n, 12-n, 13-g, 15-q, 15-s
Mains, medium-pressure process steam	T3	9-j, 9-n, 13-p
Materials Handling Equipment	R2	9-n, 12-p
Mills, coal, central	B4	11-b
Mills, coal, high-speed unit	B9	12-c
Motors, d.c.	L1	8-b
Motors, induction	L2	10-s
Motors, synchronous	L4	9-u
Motors, variable speed a.c.	L3	15-w
Motor-Generator Sets	L5	11-v
Oil, fuel and diesel	A5	14-b
Plants, adjoining industrial	I4	3-t
Power, purchased	G1	3-i
Power Transmission, bearings	M13	7-s
Power Transmission, belts	M2	7r, 7-t, 10-p
Power Transmission, chain drives	M7	9-s
Power Transmission, counter and jack shafts	M4	6-t
Power Transmission, friction clutches	M15	9-q
Power Transmission, gear speed reducers	M11	10-u
Power Transmission, geared motor reducers	M12	12-w
Power Transmission, group shaft 2-motor drives	M6	9-q
Power Transmission, group-driven machines	M3	9-q
Power Transmission, idler drives	M8	11-t
Power Transmission, individual drives	M5	7-n
Power Transmission, pivoted motor base drives	M9	9-s
Power Transmission, pulleys	M14	6-q
Power Transmission, shafts	M1	6-p, 6-s
Power Transmission, V-belt drives	M10	11-s
Power Transmission, variable-speed	M16	7-s
Process Control, automatic	N2	12-w
Production Machines	R1	8-q, 8-s, 8-t, 8-v, 8-x, 9-r, 9-t, 11-s
Pulleys	M14	6-q
Pumps, air	H3	13-n, 14-k
Pumps, boiler feed	F4	15-h
Pumps, circulating	H2	13-l, 14-i, 14-m
Pumps, oil fuel	B11	15-c
Pumps, pulverized coal	B6	9-a
Reducers, gear	M11	10-u
Reducers, motor	M12	12-w
Refuse, combustible	A4	4-a
Separators, coal, cyclone	B5	7-a
Services, general plant	K1	9-o
Shafts	M1, M4	6-p, 6-s, 6-t
Spare Parts	V1	15-a
Stacks	E4	5-h
Steam, high-pressure process	P1	13-q
Steam, interconnections for	I2	4-p
Steam, low-pressure process	P4	14-u
Steam, medium-pressure process	P3	14-r
Stokers, mechanical	C1	12-d
Superheaters	D2	9-e
Transformers, interconnection	I1	3-o
Transmission Lines, interconnecting	I3	2-q
Transmissions, variable speed	M16	7-s
Turbines, induced draft fan	E7	11-f
Turbo-Generators, bleeder	G3	12-m
Turbo-Generators, condensing	G2	11-j
Turbo-Generators, high back pressure	G4	6-j
Valves, bleeder	J1	11-l
Valves, open heater relief	F6	13-h
Valves, pressure reducing	J2	11-l
Variable-Speed Transmissions	M16	7-s
Ventilation	O1	5-t
Water, hot, for processes	P5	13-t
Water Supply, plant	K1	9-o
Water Walls	D5	9-e

oling tower in-
better vacuum.

ransformers

nterconnection
The diversity
al, may show
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acity tie line.

for Steam

or steam, com-
ir, water.

ransmission

sion line, its
way limit the
but the energy
s than power
ity contracts.

I4—Adjoining Industrial Plants

1—Mutual understanding will bring community of engineering and economic interest which may lead to interconnection with equitable distribution of benefits.

J1—Bleeder Valves

1—Install automatic control of bleed steam pressure. Consider two-bleed-point unit vs. reducing valve and throttling into second pressure main.

J2—Pressure Reducing Valves

1—Consider new type of valve, eliminating jerky action, poor pressure control, unstable operation at certain points.

2—Consider a de-superheater after the valve if saturated steam is required for the process. Improved valve will also be necessary for a superimposed high pressure cycle, so run the old plant from new boiler by reducing the pressure. Fine control is required in these cases.

K1—Plant Water Supply and General Services

1—Check the operation of house service pumps, wastage of water, compressed air, power.

2—Replace hydraulic elevators and disconnect equipment which is obsolete.

3—Shut off steam in unused mains, check leakage.

4—Check the operation to prevent loss of condensate in overflow.

5—Arrange a steam blanket to reduce contamination by air in hot surge tank.

6—Carry low level before expected high load.

L1—D. C. Motors

L2—Induction Motors

L3—Variable-Speed A. C. Motors

L4—Synchronous Motors

(For L1, L2, L3, L4 see items under L5)

L5—Motor-Generator Sets

1—Check condition of windings, bearings, brushes and rigging, commutator or slip-rings. Check adequacy of lubrication.

2—Check voltage at motor. In general, voltages more than 10 per cent above or below nameplate rating should be corrected.

3—Check loads. Relocate to secure proper loading.

4—Consider suitability of each motor for the application and operating conditions.

5—With synchronous type, check load and field strength to determine whether it is of proper value.

6—Consider advisability of carrying part of plant load by synchronous motors, to improve power factor.

7—Check suitability of controls used for the service requirements. Make sure that they embody adequate protective features.

8—Consider advisability of replacing manual controls with automatic or magnetic types.

M1—Power Transmission Shafts

1—Check alignment.

2—Check for excessive twisting or bending, indications of overload, or inadequate bearing support at points of load.

M2—Power-Transmission Belts

1—Check size against load. Consider suitability of types used for atmospheric conditions.

2—Check belt tension and suitability of take-up or tensioning facilities for service.

3—Inspect for condition and maintenance attention needed.

4—Estimate or determine linear speed. If more than 4,000-4,500 feet per minute, consider advisability of reducing.

M3—Group-Driven Machines

1—Consider advisability of making groups larger or smaller.

2—Check size of driving motor against power requirement. Oversize motors waste electricity.

3—Determine whether machines are properly grouped for requisite flexibility or maximum efficiency of operation.

4—Consider advisability of driving some machines individually.

5—Consider advisability of splitting some lineshafts into two sections connected by couplings or clutches, each section driven by a separate motor. When a few machines in both sections are to be operated, the shafts may be connected and driven by one motor. When all machines are required, disconnect the shafts and drive separately.

M4—Counter and Jackshafts

1—Check condition of bearings.

2—Check condition of loose pulley bushings, and adequacy of lubrication.

3—Check condition and operation of belt shifter. Does it wear edge of belt, or allow belt to drag on tight pulley?

M5—Individual Drives

1—Consider advisability of driving some machines in groups, from lineshafts.

2—Check suitability of each drive for service conditions.

3—Check all drives for proper installation and alignment.

4—Check size of motor against power requirement. Too large a motor wastes power.

M6—Groupshaft, Two-Motor Drives

(See item 5 under M3)

M7—Chain Drives

1—Consider suitability of type for load, speed, and service.

2—Check chains and sprockets for wear and general condition.

3—Check alignment and tension.

4—Check adequacy of lubrication.

5—If not inclosed, consider advisability of inclosing.

6—Consider advisability of replacing with some other type of drive.

2—Consider various degrees
remote control for the pr
building heating, to be o
central board equipped wi
sary indicating instrumen

N3—Meters and Contro

1—Check instruments. Re
lete, maintain all in go

2—Devise plant operating
for checking performance
ing the data for future e
building.

O1—Ventilati

1—Check suitability of av
tion, accessibility of contr
dampers, proper use of th
culation of warmed air f

2—Check actual fan speeds
in a central system, cha
inadequate.

3—Check the course of inle
able outlets.

4—Investigate local needs of
tilation, shortage of which

5—Check humidity and adj

6—Survey the natural circul
drafts. Install screens to p
from drafts.

7—Survey the processes in
gases and vapors are pro
actual pick-up of these
the ventilating system (

O2—Air Conditio

1—Control humidity in work
sitated by the manufactur
avoid dew points on co
walls.

2—Install psychrometric co
humidifiers or dryers.

3—Adjust, schedule operatio
matic.

4—Consider modern air cond
temperature and humidity
improving manufacturing pr
ucts, efficiency of labor, e
harmful dusts.

O3—Heating Syst

1—Undertake a thorough che
tem, its draining, venting,
control, return pipes. Scr
tion of various branches.

2—Check pressure drop in dis
work and in heating mains.
traps.

3—Consider a vacuum system
operation, possibly for a pa
Consider automatic contr
wrought-iron piping for ret
static general control base
temperature. Consider als
tem of zone heating and c

4—Check influx of cold air, b
tion, distribution of warme
where men work.

5—Adjust the schedule of
night and week-end periods

6—Redistribute radiators to
disconnect abandoned stack

7—Adjust thermostats to av
ing, change oversize radia
heating is an important

8—Keep windows and shop
order.

9—Consider unit heaters-cool
heaters for lower levels.

10—Consider a general chan
ing system looking towar
of natural warm air circulat
distribution through duc
heaters.

P1—High Pressure Pro

(Superheated Stea

1—Consider separately fired
for fluctuating load vs. s
boilers, reclamation of
steam in direct contact
superheating, and re-comp

(Saturated Steam

1—Check dryness, action of d

2—Consider slight throttling
sensitive to pressure change
mand is variable.

3—Verify proper draining of c
venting.

4—Check process efficiency v
sure, consider new boiler
boosters.

P2—High Pressure C
Flash Tanks

1—Consider a heat exchang
tank for high pressure con
nected to medium or low p
mains or open feed heater.

P3—Medium Pressure Pr

1—Determine most suitable
adjust bleeder and back pre
loads to maintain it.

KEY TO LOCATION OF EQUIPMEN

Part	Symbol	Location
Accumulators, hot water	W2	13-t
Accumulators, steam	W1	8-j
Air, interconnections for	I2	4-p
Air, overfire	E5	11-d
Air Conditioning	O2	5-n
Arches	D11	11-e
Ashes	A6	15-e
Ashpits	E6	12-e
Baffles	D7	7-e
Bearings	M13	7-s
Belts	M2	7-r, 7-t, 10-p
Bins, pulverized coal	B7	7-b
Blowers, soot	D10	6-e
Boilers	D1	7-e
Boilers, waste heat	D6	8-l
Bunkers, coal	B2	4-c
Burners, gas	C4	10-d
Burners, oil	C2	10-d
Burners, pulverized coal	C3	10-d
Capacitors	U2	4-j
Clutches, friction	M15	9-q
Coal, base contract	A1	2-c
Coal, spot	A2	2-e
Coal Handling Equipment	B1	2-d
Coal Yards	A3	2-f
Combustion Control, automatic	N1	11-b
Compressors, air	G6	6-o
Condensate Returns	T1	9-g, 14-h
Condensers	H1	13-i
Cooling Towers	H4	15-p
Dampers, air	D8	10-f
Dampers, gas	D9	6-d
Distribution System, electric	U1	4-i
Drives, see Power Transmission		
Drives, chain	M7	9-s
Drives, group	M3, M6	9-q
Drives, idler	M8	11-t
Drives, individual	M5	7-n
Drives, pivoted motor base	M9	9-s
Drives, V-belt	M10	11-s
Dryers, coal	B13	4-c
Economizers	D3	4-e
Engines, diesel, and generators	G5	7-l
Engines, steam	G7	13-o
Exhausters, coal mill	B8	11-a
Fans, forced draft	E1	5-f
Fans, induced draft	E2	11-g
Fans, primary air	E3	9-b
Feeders, pulverized coal	B14	8-b
Feed Water Treatment Plants	F2	14-g
Filters, feed water	F1	14-f
Flash Tanks, high-pressure condensate	P2	15-r
Fuel, base contract coal	A1	2-c
Fuel, combustible refuse	A4	4-a
Fuel, diesel oil	A5	14-b
Fuel, spot coal	A2	2-e
Fuel Oil	A5	14-b
Furnaces, electric	S1	11-x
Gas, interconnections for	I2	4-p
Generators, diesel engines and	G5	7-l
Generators, Turbo-, bleeder	G3	12-m
Generators, Turbo-, condensing	G2	11-j
Generators, Turbo-, high back pressure	G4	6-j
Heaters, air	D4	6-g
Heaters, closed	F5	12-h
Heaters, fuel oil	B12	15-d
Heaters, open	F3	13-h
Heating, plant	O3	8-q, 9-u, 11-q, 14-q, 14-x
Hoppers, coal	B10	11-d
Hydraulic Plants	Q1	13-v, 13-w, 14-v, 14-x
Instruments, metering and control	N3	13-x
Interconnections, adjoining plants	I4	3-t
Interconnections, steam, gas, air	I2	4-p
Interconnections, transformer	I1	3-o
Interconnections, transmission lines	I3	2-q
Lighting (not illustrated)	X2	
Lorries, coal weighing	B3	7-c
Lubrication (not illustrated)	X1	
Machines, production	R1	
Mains, live steam	T2	
Mains, low-pressure steam and exhaust	T4	
Mains, medium-pressure process steam	T3	
Materials Handling Equipment	R2	
Mills, coal, central	B4	
Mills, coal, high-speed unit	B9	
Motors, d.c.	L1	
Motors, induction	L2	
Motors, synchronous	L4	
Motors, variable speed a.c.	L3	
Motor-Generator Sets	L5	
Oil, fuel and diesel	A5	
Plants, adjoining industrial	I4	
Power, purchased	G1	
Power Transmission, bearings	M13	
Power Transmission, belts	M2	
Power Transmission, chain drives	M7	
Power Transmission, counter and jack shafts	M4	
Power Transmission, friction clutches	M15	
Power Transmission, gear speed reducers	M11	
Power Transmission, geared motor reducers	M12	
Power Transmission, group shaft 2-motor drives	M6	
Power Transmission, group-driven machines	M3	
Power Transmission, idler drives	M8	
Power Transmission, individual drives	M5	
Power Transmission, pivoted motor base drives	M9	
Power Transmission, pulleys	M14	
Power Transmission, shafts	M1	
Power Transmission, V-belt drives	M10	
Power Transmission, variable-speed	M16	
Process Control, automatic	N2	
Production Machines	R1	
Pulleys	M14	
Pumps, air	H3	
Pumps, boiler feed	F4	
Pumps, circulating	H2	
Pumps, oil fuel	B11	
Pumps, pulverized coal	B6	
Reducers, gear	M11	
Reducers, motor	M12	
Refuse, combustible	A4	
Separators, coal, cyclone	B5	
Services, general plant	K1	
Shafts	M1, M4	
Spare Parts	V1	
Stacks	E4	
Steam, high-pressure process	P1	
Steam, interconnections for	I2	
Steam, low-pressure process	P4	
Steam, medium-pressure process	P3	
Stokers, mechanical	C1	
Superheaters	D2	
Transformers, interconnection	I1	
Transmission Lines, interconnecting	I3	
Transmissions, variable speed	M16	
Turbines, induced draft fan	E7	
Turbo-Generators, bleeder	G3	
Turbo-Generators, condensing	G2	
Turbo-Generators, high back pressure	G4	
Valves, bleeder	J1	
Valves, open heater relief	F6	
Valves, pressure reducing	J2	
Variable-Speed Transmissions	M16	
Ventilation	O1	
Water, hot, for processes	P5	
Water Supply, plant	K1	
Water Walls	D5	

...Heaters

...perature difference, ...position of heater's ...op of steam supply. ...igh pressure closed ... of economizers or ...he latter, especially ...high back pressure

...sure closed heater ...er if the exhaust ... when some of the ...hort of power and ...would help increase

...Relief Valves

...re. Balance load ...nd back pressure ...n is wasted, proper ...re is reached, and

...s steam and power ...d winter conditions ...of steam is great, ...mies of extending ...stalling oil engines.

...ed Power

...arefully. Try to ...high peak demands. ...mitation. Watch ... improve it by in- ... motors or con-

...trification of proc- ...o reach into lower

... or electric boilers ...t or dump hydro ...ble. Consider using ...night and week-end ...pense of breakdown ... operation of own

...vestigate possibility ... utility for common

...y of grouping with ... larger amounts of ...rsity factor obtains. ...n transformer and

...urbo-Generators

...ts schedule load to ... points.

...er rates by steam ... they depend on ...ual condenser per-

...size of nozzles and ...f the generator and ...to increase capacity. ... in generator wind-

...cess steam is used, ...nit carry load fluc- ...whether back pres- ...d to carry full load ...ottles into heating

...nt of old engines, ...in excess of require- ...g turbines with at- ...ce, fuel, and oil. A ...in boilers may give ...n pressure and tem- ...further economies. ...with condensing tur- ...of circulating water ...vice versa with relo- ...

...bo-Generators

...to cover maximum ...steam demand over ...ck pressure units. ...d pressure. ...n of a bleeder tur- ...nal steam demand, ...e ratio of power to ...en a new process re- ...n pressure different

...ssure turbine opera- ...proved by installing ...r or tank on the ...In cases of sharply ...emand, an accumu- ...e boiler operation.

...Pressure Turbo- ...tors

...r a minimum heat ...d bleeder units. ... for process steam, ...over fluctuations in ...emand under bleed

...regulation load dis-

...rol with the pressure ...d is not sufficiently ...erheater after this

3—Consider improvement of the plant where power is purchased and steam is used, for process, by covering all steam demand by the back pressure turbine and purchasing less power. Also an old condensing plant may be improved by a superimposed high-pressure turbine and boilers.

G5—Diesel Engines and Generators

1—Schedule running in respect to other units and process steam demand.

2—Schedule methodic maintenance.

3—Check performance of the engine and fuel by frequent indicator diagrams.

4—Use light oils for starting in cold weather when engine is below 45 degrees F. or provide for hot water circulation.

5—Give three-quarters to full load when running.

6—Check clearness and temperature of exhaust; quality of cooling water.

7—Install recirculation.

8—Consider installing a diesel engine in a steam plant as a standby for night and week-end loads to reduce low load and banking losses.

9—Ditto for a case of sharply differing seasonal loads, when cooling water for a condensing steam unit is not available.

10—Install complete lubricating oil reclaiming systems.

G6—Air Compressors

1—Schedule operation of steam and electric driven compressors for the least loss of heat in the plant. Check indicator performance. Install air filters. Arrange inlet to draw dry air.

2—Have sufficient receiver capacity for smooth operation. Maintain tight lines. Provide disconnecting valves on large branches to prevent leakage when branches are not used.

3—Consider a centrifugal compressor for larger capacities.

G7—Steam Engines

1—Check valves and steam consumption in respect to other prime movers.

2—Schedule operation for a minimum heat loss in atmospheric exhaust or condensers.

3—Use minimum cylinder lubrication.

4—In case of large engines, watch for the pulsations in the steam mains which may have unexpected forms of vibration.

H1—Condensers

1—Schedule cleaning of condensers. Check air leakage through glands, condenser joints, atmospheric relief valve pump glands. Check circulating water leakage into condenser; install condensate conductivity meter.

2—Take circulating pump suction well below water level to prevent entrainment of air. Select better tube material for bad water. Test by water hammer condenser tubes before partial retubing to eliminate weak tubes.

3—Chlorinate circulating water to reduce slime and growths. Use zinc plate in inlet boxes to reduce corrosion. Use flaring inlets to tubes to reduce inlet erosion.

4—Check steam pressure loss through condenser bank, take out some tubes to give laned, deeper steam penetration into the bank. Check tightness of air cooling zone baffle to prevent by-passing of steam into air pump.

H2—Circulating Pumps

1—Check temperature rise in circulating water.

2—Reduce capacity in winter. Adjust capacity to load if pump is large.

3—Consider two-speed motors, if electric driven. Recirculate water to reduce ice blocking.

H3—Air Pumps

1—Check over-all performance by temperature difference between inlet mixture of air vapor and saturation vapor at inlet pressure vs. water.

2—Install steam or water air ejectors instead of reciprocating pump to improve vacum and pick up heat by circulating condensate in ejector condenser beside the raw water.

3—Check draining of inter- and after-condensers, and wear of steam nozzles.

4—In bad cases of air leakage or poor condenser design, consider outside air-vapor cooler with finned tubes set before the air pump.

5—Draw more air from the hot end of the condenser.

H4—Cooling Towers

1—Check filling and distribution of water.

2—Consider installing forced draft; check outlet air humidity.

3—Consider installing a cooling tower instead of the spray pond for better vacuum.

I1—Interconnection Transformers

1—Consider possibility of interconnection with some industrial plant. The diversity factor, hourly and seasonal, may show favorable conditions for realizing mutual benefits with a small capacity tie line.

I2—Interconnections for Steam and Gas

1—Interconnection may be for steam, combustible gas, compressed air, water.

I3—Interconnection Transmission Line

1—Interconnection transmission line, its length and cost of right of way limit the benefits of interconnection, but the energy transmitted may cost less than power purchased on public utility contracts.

I4—Adjoining Industrial Plants

1—Mutual understanding will bring community of engineering and economic interest which may lead to interconnection with equitable distribution of benefits.

J1—Bleeder Valves

1—Install automatic control of bleed steam pressure. Consider two-bleed-point unit vs. reducing valve and throttling into second pressure main.

J2—Pressure Reducing Valves

1—Consider new type of valve, eliminating jerky action, poor pressure control, unstable operation at certain points.

2—Consider a de-superheater after the valve if saturated steam is required for the process. Improved valve will also be necessary for a superimposed high pressure cycle, so run the old plant from new boiler by reducing the pressure. Fine control is required in these cases.

K1—Plant Water ... General Ser...

1—Check the operation ... pumps, wastage of wate... power.

2—Replace hydraulic ele... connect equipment wh...

3—Shut off steam in unu... leakage.

4—Check the operation t... condensate in overflow.

5—Arrange a steam blank... tamination by air in ...

6—Carry low level befor... load.

L1—D. C. M...

L2—Induction ...

L3—Variable-Speed ...

L4—Synchronou...

(For L1, L2, L3, L4 see ...

MENT

	Symbol	Location
...	R1	8-q, 8-s, 8-t, 8-v, 8-x, 9-r, 9-t, 11-s
...	T2	9-h, 10-n
ust	T4	9-n, 12-n, 13-g, 15-q, 15-s
am	T3	9-j, 9-n, 13-p
...	R2	9-n, 12-p
...	B4	11-b
...	B9	12-c
...	L1	8-b
...	L2	10-s
...	L4	9-u
...	L3	15-w
...	L5	11-v
...	A5	14-b
...	I4	3-t
...	G1	3-i
...	M13	7-s
...	M2	7r, 7-t, 10-p
...	M7	9-s
ack		
...	M4	6-t
thes	M15	9-q
t-		
...	M11	10-u
r		
...	M12	12-w
r		
...	M6	9-q
...	M3	9-q
...	M8	11-t
ives	M5	7-n
r		
...	M9	9-s
...	M14	6-q
...	M1	6-p, 6-s
..	M10	11-s
l .	M16	7-s
...	N2	12-w
...	R1	8-q, 8-s, 8-t, 8-v, 8-x, 9-r, 9-t, 11-s
...	M14	6-q
...	H3	13-n, 14-k
..	F4	15-h
..	H2	13-l, 14-i, 14-m
..	B11	15-c
..	B6	9-a
..	M11	10-u
..	M12	12-w
..	A4	4-a
..	B5	7-a
..	K1	9-o
..	M1, M4	6-p, 6-s, 6-t
..	V1	15-a
..	E4	5-h
..	P1	13-q
..	I2	4-p
..	P4	14-u
..	P3	14-r
..	C1	12-d
..	D2	9-e
..	I1	3-o
	I3	2-q
..	M16	7-s
..	E7	11-f
..	G3	12-m
..	G2	11-j
re	G4	6-j
..	J1	11-l
.	F6	13-h
.	J2	11-l
.	M16	7-s
.	O1	5-t
.	P5	13-t
.	K1	9-o
.	D5	9-e

t Water Supply and neral Services

operation of house service ge of water, compressed air,

draulic elevators and dis- pment which is obsolete.

am in unused mains, check

peration to prevent loss of overflow.

eam blanket to reduce con- y air in hot surge tank.

evel before expected high

-D. C. Motors

duction Motors

e-Speed A. C. Motors

chronous Motors

3, L4 see items under L5)

L5—Motor-Generator Sets

1—Check condition of windings, bearings, brushes and rigging, commutator or slip-rings. Check adequacy of lubrication.

2—Check voltage at motor. In general, voltages more than 10 per cent above or below nameplate rating should be corrected.

3—Check loads. Relocate to secure proper loading.

4—Consider suitability of each motor for the application and operating conditions.

5—With synchronous type, check load and field strength to determine whether it is of proper value.

6—Consider advisability of carrying part of plant load by synchronous motors, to improve power factor.

7—Check suitability of controls used for the service requirements. Make sure that they embody adequate protective features.

8—Consider advisability of replacing manual controls with automatic or magnetic types.

M1—Power Transmission Shafts

1—Check alignment.

2—Check for excessive twisting or bending, indications of overload, or inadequate bearing support at points of load.

M2—Power-Transmission Belts

1—Check size against load. Consider suitability of types used for atmospheric conditions.

2—Check belt tension and suitability of take-up or tensioning facilities for service.

3—Inspect for condition and maintenance attention needed.

4—Estimate or determine linear speed. If more than 4,000-4,500 feet per minute, consider advisability of reducing.

M3—Group-Driven Machines

1—Consider advisability of making groups larger or smaller.

2—Check size of driving motor against power requirement. Oversize motors waste electricity.

3—Determine whether machines are properly grouped for requisite flexibility or maximum efficiency of operation.

4—Consider advisability of driving some machines individually.

5—Consider advisability of splitting some lineshafts into two sections connected by couplings or clutches, each section driven by a separate motor. When a few machines in both sections are to be operated, the shafts may be connected and driven by one motor. When all machines are required, disconnect the shafts and drive separately.

M4—Counter and Jackshafts

1—Check condition of bearings.

2—Check condition of loose pulley bushings, and adequacy of lubrication.

3—Check condition and operation of belt shifter. Does it wear edge of belt, or allow belt to drag on tight pulley?

M5—Individual Drives

1—Consider advisability of driving some machines in groups, from lineshafts.

2—Check suitability of each drive for service conditions.

3—Check all drives for proper installation and alignment.

4—Check size of motor against power requirement. Too large a motor wastes power.

M6—Groupshaft, Two-Motor Drives

(See item 5 under M3)

M7—Chain Drives

1—Consider suitability of type for load, speed, and service.

2—Check chains and sprockets for wear and general condition.

3—Check alignment and tension.

4—Check adequacy of lubrication.

5—If not inclosed, consider advisability of inclosing.

6—Consider advisability of replacing with some other type of drive.

2—Consider various degrees of centralized, remote control for the processes and the building heating, to be operated from a central board equipped with all the necessary indicating instruments.

N3—Meters and Control Instruments

1—Check instruments. Replace the obsolete, maintain all in good adjustment.

2—Devise plant operating record system for checking performance and for supplying the data for future extensions or rebuilding.

O1—Ventilation

1—Check suitability of available ventilation, accessibility of control shutters and dampers, proper use of them, and recirculation of warmed air for heat saving.

2—Check actual fan speeds vs. fan design in a central system, change motors if inadequate.

3—Check the course of inlet air and available outlets.

4—Investigate local needs of additional ventilation, shortage of which hampers labor.

5—Check humidity and adjust ventilation.

6—Survey the natural circulation of air and drafts. Install screens to protect workers from drafts.

7—Survey the processes in which harmful gases and vapors are produced. Verify actual pick-up of these emanations by the ventilating system (hoods, cowls).

O2—Air Conditioning

1—Control humidity in workshops as necessitated by the manufacturing processes; avoid dew points on cool objects and walls.

2—Install psychrometric control; install humidifiers or dryers.

3—Adjust, schedule operation if not automatic.

4—Consider modern air conditioning with temperature and humidity control for improving manufacturing processes, products, efficiency of labor, elimination of harmful dusts.

O3—Heating Systems

1—Undertake a thorough check of the system, its draining, venting, thermostatic control, return pipes. Schedule operation of various branches.

2—Check pressure drop in distribution network and in heating mains. Check steam traps.

3—Consider a vacuum system for modulated operation, possibly for a part of buildings. Consider automatic control, brass or wrought-iron piping for returns, thermostatic general control based on outside temperature. Consider also modern system of zone heating and central control.

4—Check influx of cold air, building insulation, distribution of warmed air to places where men work.

5—Adjust the schedule of operation for night and week-end periods.

6—Redistribute radiators to needed places, disconnect abandoned stacks, storehouses.

7—Adjust thermostats to avoid overheating, change oversize radiators. Overheating is an important cause of loss.

8—Keep windows and shop doors in good order.

9—Consider unit heaters-coolers. Consider heaters for lower levels.

10—Consider a general change in the heating system looking toward substitution of natural warm air circulation by forced distribution through ducts and unit heaters.

P1—High Pressure Process Steam

(*Superheated Steam*)

1—Consider separately fired superheaters for fluctuating load vs. superheaters in boilers, reclamation of contaminated steam in direct contact processes, re-superheating, and re-compressing.

(*Saturated Steam*)

1—Check dryness, action of de-superheaters.

2—Consider slight throttling if process is sensitive to pressure changes and the demand is variable.

3—Verify proper draining of condensate and venting.

4—Check process efficiency vs. steam pressure, consider new boilers or pressure boosters.

P2—High Pressure Condensate Flash Tanks

1—Consider a heat exchanger or a flash tank for high pressure condensate, connected to medium or low pressure steam mains or open feed heater.

P3—Medium Pressure Process Steam

1—Determine most suitable pressure and adjust bleeder and back pressure turbine loads to maintain it.

2—Give special attention to pressure drop to points of consumption for bleeder and back pressure turbine installations.

3—Check the minimum necessary pressure and operate at it.

T4—Low Pressure Steam Mains and Exhaust Mains

1—Check pressure drop, proper draining, pressure drop in valves.

2—Change globe to gate valves if the former are throttling steam and the exhaust is partially or entirely wasted.

U1—Electrical Distribution Systems

1—Check condition of insulation. Are all conductors adequately protected against mechanical injury?

2—Check voltage drop and load carried to determine need for larger or additional feeders, or power factor correction.

3—Determine power factor. Consider advisability of correction.

4—Check condition of permanent grounds.

5—Install, or check condition of, ground detectors.

6—Investigate adequacy of circuit protective devices used.

7—See also item G1.

U2—Capacitors

1—Determine advisability of adding more units to obtain higher value of power factor.

2—Check capacitor protective devices for condition and adequacy.

3—Install, or check condition and adequacy of, signal to show whether capacitor is on or off the line.

V1—Spare Parts

1—Performance records will indicate the inventory of spare parts that should be maintained for any kind of equipment. Immediate availability of spare parts reduces shutdown losses.

2—Maintain accurate stores record.

3—Protect spare parts from deterioration.

4—Give first consideration to buying spare parts from the manufacturers of the original equipment.

W1—Accumulators, Steam

1—Check steam pressure fluctuation at variable load and losses due to unsteady firing. Check instantaneous overload capacity.

2—Consider installing steam accumulator to even up steam pressure and obtain better efficiency of combustion with increase in instantaneous capacity.

3—Maintain accumulators and automatic valves in good repair.

4—Consider a steam accumulator on the process steam lines with medium pressure which, together with steady power demand, will give better combustion efficiency.

5—Consider the possibility of reducing the number of boilers on the line by means of the accumulator which will meet the high short peaks.

W2—Accumulators, Hot Water

1—Consider storage of preheated feed water into which excess exhaust steam will be blown for increasing boiler capacity at peaks by feeding hotter water.

X1—Lubrication (not illustrated)

1—Survey and list lubrication requirements, prepare lubricating oil specifications with tolerances, substitute overlapping oils by a single oil of intermediate properties.

2—Record performances over long periods.

3—Investigate processes of reconditioning for less exacting uses.

4—Check the schedules of oiling, changing oil; verify consumption on test days.

5—Invite cooperation of lubricating experts.

6—Install filtering, settling, reclaiming apparatus with ample oil storage capacity.

7—Install oil coolers for engines, turbines, large thrust bearings.

8—Investigate methods of firing waste lubricating oil in boilers.

X2—Lighting System (not illustrated)

1—Inspect to determine need for washing, relamping, or replacement of old shades or other elements with modern units.

2—Check adequacy of illumination from standpoint of intensity, uniformity, quality.

3—Check condition of walls and ceilings to determine need for cleaning or repainting in some light color.

4—Consider advisability of installing phototube or other control of lighting system to prevent unnecessary operation. Advantage of regrouping circuits to obtain greater flexibility in operation should also be considered.